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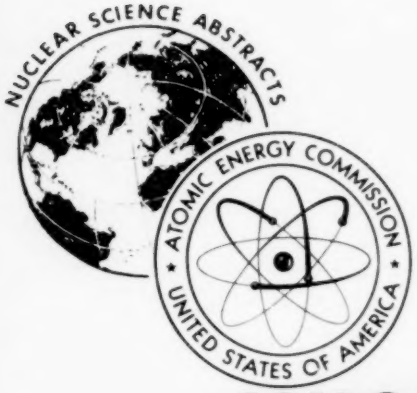

NUCLEAR SCIENCE ABSTRACTS

Volume 17 Number 15

Abstracts 24739–26943

August 15, 1963

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Volume 17, Number 15, August 15, 1963

NUCLEAR SCIENCE ABSTRACTS

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Volume 17, Number 15 August 15, 1963

NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

24739 (AECL-1692) PAPERS PRESENTED BY A.E.C.L. TO THE INTERNATIONAL CONFERENCE OF THE CANADA NUCLEAR ASSOCIATION. Held at Ottawa, Ontario, May 28-30, 1962. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1963. 222p.

Thirteen papers presented by AECL at the International Conference of the Canadian Nuclear Association are given. Separate abstracts were prepared for 2 of the papers. Eleven papers were previously abstracted for NSA. (M.C.G.)

24740 (AECL-1692(Paper I)) REACTIVITY CONTROL IN THE CANDU REACTOR. E. Siddall (Atomic Energy of Canada Ltd. Nuclear Power Plant Div., Toronto).

The characteristics of the reactor with respect to control are discussed, and the combination of methods adopted for the control of reactivity is explained. (auth)

24741 (AECL-1692(Paper V)) WINTER RAIL-LUBRICANT STUDY. L. J. O'Riley, R. W. Tolmie, and A. B. Lillie (Atomic Energy of Canada Ltd., Ottawa).

Three sets of field tests were carried out on a railway to study the "carry" distance of various rail lubricants under winter conditions. Six different greases were studied. These were applied to the rail by track lubricators. The lubricants were tagged with the radioisotope P^{32} and applied in the normal way. The amount of lubricant deposited on the rails was measured quantitatively with suitable instruments. (auth)

24742 (EUR-6.e) STUDY OF THE ADVANTAGES TO BE DERIVED FROM MIXING URANIUM COMPOUNDS AT VARIOUS DEGREES OF ENRICHMENT. L. Biondi, P. M. Gerini, O. Morocutti, G. Patrone, and M. Willems (Italatom S. P. A., Milan). Mar. 1962. 21p.

The possibility of obtaining uranium compounds of a given enrichment by mixing compounds different enrichments on an economic basis was studied. The various possibilities for the economic application of the method were demonstrated together with the advantages it offers from the standpoint of flexibility and relative independence of production. (auth)

24743 (EUR-183.e) NUCLEAR INSTALLATIONS IN THE COUNTRIES OF THE EUROPEAN ATOMIC ENERGY COMMUNITY. Second Edition. (European Atomic Energy Community). Jan. 1, 1963. 43p.

A list of nuclear installations that already exist, that are under construction, or are being planned in the member countries of Euratom is presented. It comprises, for each installation, a short description limited to the main characteristics of each installation. The more important enterprises that are known to have participated in the building of the installations are also mentioned. (P.C.H.)

24744 (NAA-SR-Memo-8074) VIBRATION AND SHOCK, HIGHWAY TRANSPORT BETWEEN SANTA SUSANA MOUNTAINS AND EDWARDS AIR FORCE BASE. E. L. Gardner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 25, 1963. Contract [AT(11-1)-Gen-8]. 23p.

A road test, performed on a SNAP 10A mass mockup system, indicated that shock and vibration inputs under actual conditions were not excessive. During the course of travel from the Santa Susana field laboratory to Edwards Air Force Base, and during field trials at Santa Susana, the test system was subjected to only two accelerations exceeding 2 g, and no inputs exceeded 2.4 g. It was concluded that shock and vibration to SNAP systems from highway transportation can be adequately controlled by: selecting the appropriate vehicle; providing proper packaging; specifying route and speed limits for various driving conditions; using ordinary care in loading and unloading; and including suitable shock monitoring instruments with the shipment. (P.C.H.)

24745 (NP-12748) GREECE AND ATOMIC ENERGY. Sotos D. Boukis (Greece. Atomic Energy Commission, Athens). June 1962. 34p.

Descriptions of the efforts, activities, and attainments of the Greek Atomic Energy Commission and other establishments are given. Special attention is given to the Democritus nuclear research center, and general specifications of the Democritus reactor are included. Some of the major problems that were solved during the course of the years by the GAEC are mentioned. (P.C.H.)

24746 (PNE-201F) FINAL REPORT OF WEATHER AND SURFACE RADIATION PREDICTION ACTIVITIES FOR PROJECT SEDAN. (Weather Bureau, Las Vegas, Nev.). Nov. 1962. 48p.

Project SEDAN was designed as a cratering experiment in which a nuclear device of about 100 kilotons equivalent high-explosive yield and less than 30% fission was detonated at a depth of 635 ft. Provisions made for weather observations, weather prediction, and radiation prediction in support of the test are described. (C.H.)

24747 (PNE-225P) PART I. CHARACTERISTICS OF FALLOUT FROM A DEEPLY BURIED NUCLEAR DETONATION FROM ABOUT 3 TO 150 MILES FROM GROUND ZERO. K. H. Larson, B. W. Kowalewsky, R. A. Wood,

H. M. Mork, and D. Paglia. PART II. AERIAL RADIOMETRIC SURVEY. R. B. Guillou (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Aug. 1962. Project SEDAN. Contract AT-04-1-GEN-12. 64p.

The physical and radiological characteristics of fallout from the detonation of a nuclear device buried in desert alluvium at 635 feet below ground surface were determined by aerial radiometric survey. The fallout collections were made from less than 3 miles to about 100 miles from ground zero. The studies included delineation of the radiation intensity within the fallout pattern; determination of the distribution of radioactivity as a function of particle size per unit area, mass per unit area per particle size fraction, and time of arrival of fallout; determination of the radioactive field decay; and the determination of isotopic fractionation of certain fission products, including Zr^{95}, Sr^{89} and Sr^{90}, as a function of particle size, and time of fallout. These objectives were satisfactorily met by fallout collections obtained from 74 of the 92 stations established. Samples were processed with respect to size fractions and data are being evaluated. Radiochemistry is in progress on representative samples determining specific radionuclides permitting estimates of isotopic fractionation. Gamma energy spectral measurements made at 100 feet above the ground surface resulted in the tentative identification of the radionuclides I^{131}, Te^{132}, I^{132}, W^{187}, and $Ba^{140}-La^{140}$. (auth)

24748 (SCR-180) CRATER FORMATION BY EXPLOSION AND RELATED TOPICS. An Annotated Bibliography. Volume I. W. E. Taylor and R. P. Reed (Sandia Corp., Albuquerque, N. Mex.). May 1960. Contract [AT(29-1)-789]. 124p.

References (437) on the effects of subsurface explosions in both natural and artificial media are given to reports in U. S. and foreign journals published from 1938 through 1960. Cratering, ground displacement, throw-out characteristics, and similar close-in phenomena are emphasized. Considerable current information on phenomena and the application of nuclear explosives (Project Plowshare) is included. There are references on instrumentation, the analytic mechanics of materials, and the properties of media in which explosions are conducted. Abstracts are included for most references. (P.C.H.)

24749 (STI/DOC/10/16) IAEA RESEARCH CONTRACTS. THIRD ANNUAL REPORT. Technical Reports Series No. 16. (International Atomic Energy Agency, Vienna). 1963. 84p.

Brief summaries of all final reports relating to contracts that were completed during 1962 are presented. 20 summaries are included. (P.C.H.)

24750 (UCRL-10624) CHEMISTRY DIVISION ANNUAL REPORT, 1962. J. M. Hollander, F. L. Reynolds, and J. C. Wallmann, eds. (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1963. Contract W-7405-eng-48. 348p.

Radioactivity and Nuclear Structure. Information is reported on the following: Hyperfine structure anomaly in the spectra of Li-6 and -7, Mossbauer effect in Te-125, quadrupole splitting in the spectrum of Te, energy levels in Tl isomers, preparation and properties of At-204 and -206, alpha decay of Pa-227, formulas for the development of a semiempirical mass law, and pairing forces for deformed nuclei, nuclear charge distribution in the fission of excited U-236, and theoretical band head spectra of Pa, Np, Bk, and Es. Fission. Information is reported on the following: Yields of I-135, Xe-135, and Cs-135 in the fission of excited U-236, momentum transfer in C-12, He-4, Ne-20, and O-16 reactions with U-238, momentum transfer in O-16 reactions with Au-197 and Ho-165, delayed gamma emission in fission, alpha emission in the spontaneous fission of Cf-252, half lives of Fm isotopes, spontaneous fission half lives of Cf-250 and -254, kinetic energies of fission-fragment Bi-209, Au-197, and Th-232 from U-238, and deformation energies of charged rotating drops. Nuclear Reactions. Information is reported on the following: Optical model analysis of 10-Mev proton elastic scattering, polarization of 22-Mev protons in p-d elastic scattering, elastic and inelastic scattering of He ions on C-12 and N-14, heavy ion reactions with Pr-141, equilibrium charge distributions in O-16 reactions with Ce-138, in C-12 reactions with Nd-142, in Ne-20 and Ne-22 reactions with Ba-138, in C-12 reactions with Nd-142 and Pr-141, and in N-14 reactions with Pr-141, and determinations of nuclear radii from heavy ion elastic scattering measurements. Physical Chemistry. Information is reported on the following: Surface ionization studies of tungsten crystals for mass spectroscopy, properties of carboxylic acid resins for alkali ion exchange in concentrated solutions, hydrobromic acid separation from carbon tetrachloride-TBP systems by solvent extraction, focusing theory in electrophoresis and the separation of actinides and rare earths, chemical separation of transuranic elements from silicate rocks, crystal and molecular structure of In_2I_6, absorption spectrum of Eu-151 at 4.2 and 87°K, nuclear magnetic fields of Au-197 in Co, Fe, and Ni, and pressure effects on Mossbauer absorption in Dy-161. Instrumentation. Information is reported on the following: performance of iron-free beta spectrometers, resolution of Li-drifted surface-barrier detectors, data recording systems, and variable amplifiers for gain stabilization. (D.E.B.)

24751 THE DEVELOPMENT OF ATOMIC ENERGY IN FRANCE. Sumio Hori, Akira Tachibana, Shoji Nomoto, Tetsuo Aochi, Masatoshi Kobayashi, Tatsuro Yamamoto, and Kiyoaki Taketani. Genshiryoku Kogyo, 9: 7-38(1963). (In Japanese)

Review papers concerning the present status of the atomic energy studies in France which were presented at the Technical Conference on Atomic Energy in November 1962 in Tokyo summarize the work carried out in the following fields: general development programs, the heavy-water power reactor EL-4, the fast reactor Rapsodie, spent fuel element processing and plutonium studies, fabrication of the fuel elements for the graphite–CO_2 reactor, and the fuel cycle of the natural uranium–graphite gas-cooled reactor. (TTT)

24752 PROPOSED EXPERIMENT TO MEASURE EFFECTS OF GROUND ROUGHNESS ON THE DOSE RATE FROM FALLOUT RADIATION. C. Eisenhauer (National Bureau of Standards, Washington, D. C.). Health Phys., 9: 503-6(May 1963). (In English)

An experiment designed to measure the effects of microscopic ground roughness on dose rates from fallout radiation is described. Existing calculational procedures for predicting these effects are first discussed. The effect of rough ground is then discussed in terms of a correction factor to the angular distribution of radiation above a smooth plane. An experiment designed to measure this correction factor is discussed in detail. (auth)

24753 ROLE OF THE OFFICE OF EMERGENCY PLANNING. Carey Brewer (Office of Emergency Planning, Washington, D. C.). Health Phys., 9: 545-9(May 1963). (In English)

A national state of readiness must be achieved and maintained for the mobilization of the Nation to deal with all degrees of emergency such as cold war, limited war, and general war including attack upon the United States. National security and current economic actions should be mutually supporting with due attention directed to emergency preparedness measures which will contribute to the improvement of our current economy or national well-being. The acceleration of mobilization can be accomplished most effectively and efficiently through the performance by departments and agencies of Government of those emergency preparedness functions related to their established roles and capabilities. The responsibility for emergency preparedness involves virtually every department and agency of the Federal Government, and there is a need to provide a central point of leadership and coordination in the Executive Office of the President. Therefore, the Office of Emergency Planning (OEP) was formed to advise and assist the President in the coordination and in the determination of policy for the emergency plans and preparedness assignments of the Federal departments and agencies designed to make possible the mobilization at Federal, State and local levels of the human, natural and industrial resources of the Nation to meet all conditions of national emergency. OEP is responsible for the preparation of plans and preparedness programs with respect to organization and the functioning of the Federal Government under mobilization conditions and with respect to specific areas of emergency Federal activity necessary in time of war which are not performed in the normal operations of the regular departments and agencies. OEP also exercises its assigned statutory operating functions relative to defense production, stockpiling, and development and maintenance of the mobilization base. (auth)

24754 RADIOACTIVE PRODUCTS. Trombay, India, Atomic Energy Establishment, [1963]. 130p.

A catalog of radioisotopes and other radioactive products is presented. The neutron irradiation facilities are described briefly. Besides radioisotopes, the following are listed: medical isotopes; P^{32}, S^{35}, I^{131}, and C^{14} compounds; industrial and radiography sources; neutron sources; and miscellaneous radiation sources. (D.L.C.)

24755 DEVELOPMENTS IN TECHNICAL CAPABILITIES FOR DETECTING AND IDENTIFYING NUCLEAR WEAPONS TESTS. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-EIGHTH CONGRESS, FIRST SESSION, MARCH 5, 6, 7, 8, 11, AND 12, 1963. (United States. Congress. Joint Committee on Atomic Energy). 523p. (GPO)

Hearings were held before the Joint Committee on Atomic Energy, Eighty-Eighth Congress, March 5 to 12, 1963, on developments in technical capabilities for detecting and identifying nuclear weapons tests. Technical developments of Project Vela, the national program to improve capability of detecting nuclear tests in outer space and underground, were reviewed. Topics discussed include methods for the detection, identification, location, and verification of nuclear explosions, epicenter location by seismic means, onsite inspection methods, the present status of diagnostic aids, the present status of the theory of decoupling based on experimental data and theoretical techniques, ground-based and satellite-based systems for detection of high-altitude nuclear tests, and technical and other aspects of nuclear weapons test ban proposals. (C.H.)

24756 4th INTER-AMERICAN SYMPOSIUM ON THE PEACEFUL APPLICATION OF NUCLEAR ENERGY, MEXICO CITY, APRIL 9-13, 1962. [VOLUME] I. (Inter-American Nuclear Energy Commission, Washington, D. C.). 340p. $3.50(IANEC).

Thirty-two papers are presented in Volume I of the Fourth Inter-American Symposium on The Peaceful Application of Nuclear Energy. Topics covered include: physics, engineering, and geology. Separate abstracts were prepared for 27 papers. Five papers were previously abstracted for NSA. (M.C.G.)

24757 REPRESENTATION OF THE POTENTIAL OF TWO NUCLEONS. J. Tharrats, O. Cerceau, and O. Rojo (Universidad Central de Venezuela, Caracas). p.19-24 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

An attempt was made to find the conditions under which the potential v of two nucleons can be written, whether as: nonlocal potential, dynamic potential, static potential with a repulsive core, and effective mass. The potential v is a diagonal operator on a different base than the r's. It was found that any potential dependent on r and p may be expressed as the sum of the moments of a potential. The conditions of hermiticity and indistinguishability of the two nucleons were applied. A method for ascertaining the development of a potential dependent on velocity was the diagonalization of the nonlocal potential. The potential obtained, considering the hermiticity in development, is

$$v = \sum_{n,m,e} (-)^{m+l} \frac{1^{n+m+l}}{n!\,m!\,l!} (P \overset{(l)}{\cdots} P\{V_1 \overset{(m)}{\cdots} V_1[P_1 \overset{(n)}{\cdots} (P,V)]\}),$$

$(n + m + l = 2)$, which in a first approximation takes the form: $v = V - (a_1^2/M)\, pVp + (a_1^2/2M)\,(p^2V + Vp^2)$. (auth)

24758 NUCLEAR DISINTEGRATION AND THE POLES OF THE S FUNCTION. F. Medina Nicolau and U. Oseguera (Universidad Nacional Autónoma, Mexico City). p.25-9 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

The behavior in time of the disintegration of a compound particle into two particles was studied. It was assumed that all of these particles are punctual and that, except at the point of contact, the two last move as free particles. The S function associated with the system, whose poles in the complex plane of the moment govern the disintegration phenomenon, is determined by the requisite that the total probability of finding the system in the form of a compound particle or in the form of two particles be independent of time. The parameters that determine the position of the poles of this function are given by a constant that measures the speed with which the compound particle disintegrates and the binding energy of that particle. It was found that the probability of disintegration for a given value of binding energy departs further from the exponential law as the speed with which the decay is accomplished increases. Consideration was also given to the case in which the binding energy is negative. Finally, the relation between this phenomenon and that of the dispersion of two particles through the formation of a compound particle at the point of contact is discussed. (auth)

24759 GAMMA RAY ASTRONOMY. I. Escobar V. (Universidad Mayor de San Andrés, La Paz, Bolivia), R. Schulczewski, G. Clark, K. Suga, and K. Murakami. p.31-46 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In English)

An analysis was made of the characteristics of cosmic radiation of the high-energy gamma type and the production

of such radiation in our galaxy and other galaxies, assuming certain parameters on the basis of recently obtained results. A study was made of the number of particles of this nature that can indicate on a detector the possible ways of separating showers generated by gamma rays from the much more frequent ones produced by protons. The equipment used included: a 60 m^2 plastic scintillator detector; 17 density detectors, likewise of plastic, each 1 m^2; five detectors, each 1 m^2, to determine the arrival time of each individual shower; seven Cherenkov detectors to study the distribution of energy flow; a large cloud chamber with 17 steel plates; and a Simpson neutron monitor. Some of the preliminary results already obtained with this equipment at an altitude of 5200 meters above sea level are described. (auth)

24760 CIRCUIT OF COINCIDENCES OF BIDIMENSIONAL REPRESENTATION. Horacio E. Bosch (Universidad Nacional, La Plata, Argentina) and Daniel J. Horen. p.47-54 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

The principal properties and figures of a system of coincidences of bidimensional representation are described. The result of the measurement is the establishment of a diagram of 63 × 63 channels showing the number of times that the coincidence m,n appears (m,n = 1, ... 63). The circuit and the use of electronic computers for processing the information given by the equipment are discussed in outline. Mention is made of the measurements effected on gamma-gamma coincidences for the particular case of the disintegration of Sb^{126} (19 minutes). (auth)

24761 THE USE OF TOURMALINE AS A NEW THERMAL NEUTRON DOSIMETER. José Israel Vargas and Geraldo Aurélio Cordeiro Tupinambá (Universidade de Minas Gerais, Sao Paulo, Brazil). p.67-70 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In English)

The neutron irradiation of tourmalines, natural complex boron silicate crystals of fixed boron composition, leads to the formation of two absorption bands at 700 and 1200 mμ, due to color centers resulting from the $B^{10}(n,\alpha)Li^7$ reaction. Spectrophotometric examination of these induced absorption bands shows that a linear relationship exists between the neutron dose and the logarithm of the change of the absorption coefficient, between 3.0×10^{13} and 3.6×10^{14} nvt for a crystal plate 1.00 mm thick. The thermal stability of the color centers as well as certain geophysical implications of the results are discussed. (auth)

24762 MEASUREMENTS OF PROTON-GAMMA ANGULAR CORRELATION OF THE $Be^9(d,p\gamma)Be^{10}$ (3.37 Mev) AND THE THEORY OF DISTORTED WAVES. Jorge Zamudio (Universidad de Chile, Santiago). p.77-87 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

Measurements were made of the angular correlation, in the reaction plane and in a perpendicular plane, between the group of protons that leads to the first excited state of Be^{10} and the gamma radiation of de-excitation of that level, utilizing deutons of 6.6 Mev of the cyclotron of the Faculty of Sciences of Orsay, France. The protons emerging at 20° (Lab.), which correspond to the peak of stripping, were used. The coincidences were measured by means of a conventional slow-rapid system and a time-amplitude converter, both with pulses obtained from scintillation detectors. The experimental results were compared to the predictions derived from the theory of distorted waves, in order to conduct the tests as proposed by Huby, Refai, and Satchler. The parameters of correlation, adjusted by the method of least squares, were: $A_2^0 = 0.26 \pm 0.05$, $\lambda = 0.37 \pm 0.07$, and $\phi_0 = -11° \pm 4°$. It was concluded that the theory mentioned is applicable to this reaction, at the energy utilized, even though the amplitude of the distortion does not exactly correspond to the calculations based on the optical potential. (auth)

24763 RADIOACTIVE EFFLUENT CONTROL IN A FUTURE NUCLEAR ENERGY INDUSTRY. Walter G. Belter (U. S. Atomic Energy Commission, Washington, D. C.). p.97-114 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In English)

The adoption of more stringent radiation protection guides in recent years resulted in a vigorous and expanded research and development program in radioactive waste control. Future requirements for more efficient waste management systems and the development of methods that minimize release of radioactivity to our environment are discussed. Present radioactive waste handling practices and experience in the United States for different types of waste are summarized. The effectiveness of various treatment systems for large-volume, low-activity wastes from laboratory and reactor operations is analyzed. Tank storage of smaller-volume, high-activity waste is briefly discussed. The scope and objectives of the waste research and development program are summarized. New developments in ion exchange, synthetic mineral exchange materials, and hydrofracturing are discussed as potential future methods for control of low and intermediate level waste. The possibilities of recycling and/or reusing processed waste streams in laboratory or reactor systems are also discussed. The present status of calcination and/or fixation of high activity waste from chemical reprocessing of irradiated reactor fuel is briefly described. It is noted that volumes of solid, low-hazard potential wastes continue to increase in the United States. Recent land burial and sea disposal operations are discussed. The future utilization of certain geologic formations for storage of this type of waste, in lieu of shallow land or sea disposal, is described. Recent development work on the ultimate storage of high-activity waste in salt and impermeable rock formations is summarized. Brief reference is made to economic considerations involved in the handling and disposal of radioactive wastes. Although treatment and disposal costs are substantial, they should not constitute a major obstacle in the development of a nuclear energy industry. (auth)

24764 RAEP REACTOR: FINAL DESIGN AND PRESENT STATUS OF ITS DEVELOPMENT AND CONSTRUCTION. Jorge Cosentino (Comisión Nacional de Energía Atómica, Argentina). p.115-19 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

The Argentine National Atomic Energy Commission (CNEA) presented to the Third Inter-American Symposium on the Peaceful Application of Nuclear Energy, held in Brazil in 1960, a paper on the planned design accepted at that time for its second research reactor. The various changes introduced in that design are reviewed. The progress of the project and the stages of construction already

completed are described. The results obtained in some of the research programs that are being carried out in connection with the project are outlined. (auth)

24765 CONSIDERATIONS ON THE LOCATION OF A NUCLEAR REACTOR IN THE VALLEY OF MEXICO BASIN. A. Morales y Amado, A. Roldán G., and L. Lara T. (Instituto Politécnico Nacional, Mexico City). p.121-31 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

A preliminary study was made of the chief characteristics that would determine the location of a reactor in the Valley of Mexico basin. This study was based on data existing in several government agencies, in research institutes, and in observatories in Mexico City. From this study it was tentatively concluded that a reactor location that would scarcely affect neighboring population, considering air contamination and wind direction, as well as contamination of drinking water, would be in the region known as the sub-basin of Cuautitlán, between Atizapán de Zaragoza and Cuautitlán. This region, also, is little affected by meteorological phenomena. (auth)

24766 CHARACTERISTICS OF PLANTS OF THE GCR TYPE (GAS-COOLED REACTORS) AND THEIR REGULATION AT PARTIAL LOAD WORKING WITH SINGLE STEAM CYCLES. Jorge Spitalnik (Comisión Nacional de Energía Atómica del Uruguay, Montevideo). p.133-41 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

In the Latin American countries that are producers of uranium, an attempt will be made to adopt power plants that operate with natural uranium-graphite reactors, for economic reasons and for the sake of independence in fuel supply. Reactors of the natural uranium-graphite type offer the advantage that vast experience has been obtained in this field of power generation. Reasons that make CO_2 as a coolant attractive are that it is cheap, easily produced industrially, inexpensive to purify, and has good qualities from the thermodynamic, nuclear, and safety standpoints. Reactors of the GCR type have the additional advantage of permitting a high percentage of building materials and labor native to the Latin American countries to be used. For reasons of efficiency and regulation, the GCR plants already built have dual steam cycles. The present tendency, however, is to use a single steam cycle, which simplifies and reduces the cost of the plant. Single-steam plants present a major problem as to regulation at partial load. This problem was studied, and certain conclusions were reached through various regulation programs: first it is desirable to regulate the temperature of the feedwater of the heat exchanger, whether by means of extractions from the turbine or a by-pass of live steam to the feeding pipes, and second this regulation makes it possible to keep the steam conditions at the entrance of the turbine, the temperatures of the gas at the entrance and exit of the reactor, and the boiling point in the heat exchanger practically constant. (auth)

24767 CONSIDERATIONS REGARDING TREATMENT OF THE WATER OF A CONVERTIBLE NUCLEAR REACTOR. Juan Lartigue Gordillo (Comisión Nacional de Energía Nuclear, Mexico City). p.143-52 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

The problem of the treatment of the water in a critical reactor of zero power operated initially as subcritical, was studied. During its subcritical stage, this reactor will operate with natural uranium and light water, and during its critical stage with the same natural uranium and heavy water. The specifications that must be met in the analysis of the water of a reactor are outlined along with the most common problems and their treatment as compared with conventional treatment. A system of treatment for the subcritical phase is proposed in accordance with the considerations given and with the analysis of the water available at the reactor site. A system of treatment is proposed for heavy water as well as for the cationic resin (deuteration), endeavoring use to be made of the equipment installed during the subcritical phase so far as possible, for reasons of economy. Consideration is given to the most advisable type of resin among those available on the market, along with an estimate of costs. (auth)

24768 SOME APPLICATIONS OF FLUIDIZATION TECHNIQUES IN NUCLEAR REACTOR FUEL CYCLES. Clarke Williams (Brookhaven National Lab., Upton, N. Y.). p.153-62 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In English)

The technique of fluidization of particulate matter by gases or by liquids as applied to nuclear reactor fuel cycles is discussed. Fluidized beds of inert granular material were used as a heat transfer medium in the processing of reactor fuels first with anhydrous HCl to volatilize zirconium as the tetrachloride and then with fluorine gas to volatilize the uranium as the hexafluoride. The successful development of the HCl step through a small pilot plant stage, and the fluorination step as far as bench scale operations is described. Another use of fluidization is to move particulate fuel in sodium- or other liquid-metal-cooled reactors. The performance of UO_2 particles fluidized in NaK was studied. The results were sufficiently encouraging to plan further experiments with sodium at elevated temperatures. A number of different reactor designs based on a fuel cycle utilizing fluidization were evaluated. Some of the more important features of these reactors are described. (auth)

24769 LATTICES OF NATURAL URANIUM AND LIGHT WATER. F. E. Prieto and G. S. de Oyarzábal (Universidad Nacional Autónoma, Mexico City). p.163-9 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

The results of a calculation of subcritical lattices of light water and natural uranium are presented. The calculation was made by hexagonal geometry using a first-order approximation. First the constants of infinite reproduction were obtained using the well-known four-factor formula; the value of $\eta = 1.327$ was taken for the number of neutrons produced by absorption of a thermal neutron; for the thermal utilization factor and the resonance escape probability the conventional formulas were used; and for the fast fission factor the semi-empirical formula of Tavernier was used. After this, the Laplacian factor was calculated, using for the migration area the values calculated with the semi-empirical formula of Tavernier. Both for the constant of infinite reproduction and for the Laplacian constant, the values calculated agree reasonably with the experimental values measured in some reactors. Afterwards, the amounts of uranium necessary for obtaining a given amplification for each lattice were calculated, and an estimate was made of the effect of the water reflector.

Finally, the amounts of uranium were adjusted to the conditions of the hexagonal geometry of the lattice. (auth)

24770 OPTIMUM PREPARATIONS OF HETEROGENEOUS SCREENS OF URANIUM OXIDE AND NATURAL URANIUM FOR VARIOUS MODERATORS. A. Morales y Amado, A. Serment C., and J. Calvillo (Instituto Politécnico Nacional and Universidad Nacional Autónoma, Mexico City). p.171-4 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

A research program was planned dealing with heterogeneous nuclear reactors whose fuel would be based on unenriched uranium. Optimum preparation of heterogeneous screens of uranium oxide for various moderators including H_2O, D_2O, and C, and optimum preparation of heterogeneous screens of natural uranium for various moderators including H_2O, D_2O, and C are described. (auth)

24771 VISCO-ELASTIC STRESS-STRAIN RELATIONS FOR CONCRETE AND THEIR APPLICATION IN SHIELDS OF NUCLEAR REACTORS. Luis G. Gorostiza (Comisión Nacional de Energía Nuclear, Mexico City). p.175-80 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

The analysis of stresses and deformations in concrete members is a problem of interaction of the elastic, viscous and thermal effects of that material, whose properties vary with time. The problem is more complicated when high temperatures are involved. A relation between the stress tensor and the strain tensor is proposed to take into account the deferred deformation of concrete and allow temperature to be involved. This relation results from the simultaneous consideration of the theory of linear viscoelasticity for a homogeneous and isotropic body and the theories of N. J. Arutiunian and I. E. Prokopovich for concrete in a uniaxial state of stresses. This relation is applied, by way of illustration, to the analysis of stresses in a thick bar of concrete with a circular axis, submitted to thermal gradients due to the generation of heat by absorption of gamma rays. This is a case that occurs in the shield of a nuclear reactor. (auth)

24772 ABSORPTION OF GAMMA RADIATION BY BUILDING MATERIALS USED IN MEXICO. C. Archundia and A. Moreno y Moreno (Comisión Nacional de Energía Nuclear, Mexico City). p.181-9 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

Observations made on absorption of gamma radiation from a Co^{60} source by some of the building materials commonly used in Mexico are presented. The method employed consisted in obtaining absorption curves for the various materials with the source, using a scintillation detector for gamma radiation and a single-channel pulse-height analyzer. The measurements of the absorbing effect of each material are given in graphs and tables with indications of absorption of total radiation and of the analyzed radiation. The information gathered on absorption of total radiation is useful, since this is what must be considered in connection with protection problems. The method employed can be used to determine absorption curves for other materials as well as to determine the thickness necessary to reduce radiation to a given percentage. (auth)

24773 FLUCTUATIONS AND AUTOCORRELATION FUNCTIONS OF THE NUMBER OF NEUTRONS IN A REACTOR. Marcelo Guillén Ceballos (Universidad Nacional Autónoma, Mexico City). p.191-9 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

Considering that the numbers of neutrons and radioactive nuclei fission products follow a Markov process, the Chapman-Kolmogoroff equation was employed to obtain, in a general form, the differential equation satisfied by the function of probability distribution of the number of neutrons and radioactive nuclei that decay by emission of a neutron in a nuclear reactor. This equation was solved, under generally nonstationary conditions, for the following cases: a reactor without a source and without retarded neutrons; a reactor with a source and without retarded neutrons; and a reactor with a source and with retarded neutrons. The results obtained in each case, for the average number of neutrons in the reactor and the normalized standard deviation, generally agree with those obtained by other authors using different methods. This method was extended to the joint distribution, for two times, of the number of neutrons in a reactor, and this made it possible, by integration of the resulting differential equation, to obtain a general expression for the autocorrelation function of the number of neutrons. This function was obtained for the cases mentioned above, and it is shown that, for the nonstationary case, the condition of symmetry with respect to the two times is met only in a limited sense. (auth)

24774 INFLUENCE OF THE NEUTRON SPECTRUM ON THE ECONOMY OF REGENERATIVE THORIUM REACTORS. Sérgio de Salvo Brito (Comissão Nacional de Energia Nuclear, Rio de Janeiro). p.201-11 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Portuguese)

The construction of a regenerative reactor employing the $Th-U^{233}$ cycle depends upon a preliminary study of the nuclear parameters of the system, since two factors drastically limit the freedom of a nuclear project: the regeneration factor (η) of the fuel, imposed by the condition of a unit conversion factor, and the parasitic capture of neutrons by Pa^{233}, which is a function of the neutron flux. On the other hand, the production of U^{233} can be improved by increasing the resonance capture of the thorium; the resulting "hardening" of the neutron spectrum tends, however, to deteriorate the η of the U^{233}. An attempt was made to measure this effect and determine how the neutron economy of the system could be improved by a slight displacement of the neutron spectrum in the direction of epithermic energies. The excess of thermal neutrons available for parasitic capture (moderator, structures, etc.) and leakage was calculated as a function of the specific power and of the percentage of resonance captures. The results are presented in graphic form. The results were applied in the case of reactors moderated with heavy water, taking for reference a 1200 Mw reactor. The results were compared to those for two other D_2O-moderated reactors: a $U^{235}-Th$ converter reactor with a conversion factor of less than 1 and a natural uranium reactor, from the standpoint of the cost of the fuel cycle. The advantages of control by means of spectral dislocation were studied for the foregoing cases. (auth)

24775 DOUBLE SPECTROGRAPH TECHNIQUE FOR THE EXPERIMENTAL STUDY OF ANGULAR DISTRIBUTIONS OF NUCLEAR REACTIONS. J. Rickards, M. E. Ortiz de López, M. Mazari, F. Alba, J. Dorantes, and L. Velázquez (Universidad Nacional Autónoma, Mexico

City). p.213-22 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

The difficulty that is encountered in the reproducibility of intensities of angular distributions of nuclear reactions, both by reason of the deterioration of the targets and by reason of the uncertainty of the absolute measurement of the ionic flow during their exposure, suggested the construction of an auxiliary magnetic spectrograph of the Bainbridge-Buechner type, similar to that employed for recording the products of nuclear reactions, to be used as a means of standardizing the intensities on the basis of a constant number of elastic collisions of the substance under study. Oriented at an angle of 90° with respect to the incident beam, the magnetic poles of the unit have a radius of curvature of 29 cm and a gap of 1.9 cm, achieving a uniform field of 14 kgauss without appreciable saturation of the iron. A nuclear magnetic resonance fluxmeter is employed to measure the magnetic field. Without breaking the vacuum of the photographic camera, it is possible to displace a scintillation counter located in the region of maximum resolution of the spectrograph and replace it with a nuclear plate 5 × 25 cm in size. This last is preferred to correct, in terms of elastic collisions, the precise energy of the projectile. The counting equipment, which permits following the evolution of the target during the experiment, is provided with adjustable lattices for the purpose of simultaneously distinguishing two groups of particles elastically bounced back by different substances in the target. Based on monoenergetic groups of elastic particles from very thin targets, the optimum focus of the photographic plate was found experimentally. Using as a standard the monoenergetic alpha particles of Po^{210}, the calibration curve of the instrument was determined. (auth)

24776 PLAN FOR AN ADVANCED LABORATORY OF NUCLEAR SPECTROSCOPY. M. Mazari, F. Alba, G. López, and P. Mello (Universidad Nacional Autónoma, Mexico City). p.223-38 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

With the development and joint employment of Van de Graaff-Tandem electrostatic accelerators and multisectional magnetic spectrographs of broad range and high resolution (stereo-spectrographs), a powerful and efficient means was achieved for experimental determination of the principal physical characteristics required in the investigation of a theory of the nucleus. Based on the information available on atomic masses, an analysis of the range of study with the equipment mentioned (Tandem energies of 13 Mev) shows in principle the possibility of exploring, starting with nuclei that are stable in nature, the spectroscopy of some 76% of the known nuclides and of creating by nuclear reactions around 9% of new isotopes. Spectral analysis of heavy nucleons emitted in nuclear reactions induced at these energies can be done with a stereo-spectrograph that has the following properties and characteristics: radius of magnetic poles 50 cm, magnetic field variable between 3 and 16 kgauss, 19 gaps located in two opposite quadrants of the toroid in order to obtain simultaneous angular distributions between 0° and 170°, two 3 cm gaps at 50° and 130° with respect to the direction of the incident beam of particles, relation of maximum to minimum energy = 2.29, maximum energy for protons and alpha particles = 32 Mev, approximate weight = 24 tons, and electrical supply = 120 KVA. The construction of a spectrograph of this type, similar to that designed and built at the Massachusetts Institute of Technology, was recently started at the Van de Graaff Laboratories of the National University of Mexico. (auth)

24777 THE GENESIS OF URANIUM ORES. Hans H. Adler (U. S. Atomic Energy Commission, Washington, D. C.). p.241-52 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In English)

The formation of uranium ores is a function of many geochemical and geologic factors governing the mobility of uranium in the earth's crust. In continental sediments, which contain the largest uranium reserves in the United States, deposition is associated with paleofluviatile features that are conducive to fluid movement and provide suitable reducing conditions. Isotopic studies of sulfide minerals paragenetically equivalent to uranium minerals comprising sandstone-type ores indicated that hydrogen sulfide formed during diagenesis by bacteriologic processes was probably the chief precipitating agent. This conclusion was based largely on relatively high S^{32}/S^{34} ratios, which were obtained also during in vivo experiments with the Desulfovibrio species. Isotopic data on sulfides from sediments of various ages and regions suggested that similar processes were operative for all sandstone-type uranium deposits. Evidence of the possible involvement of hydrogen sulfide produced during maturation of petroleum or by bacteriogenic reduction of sulfate in the sediments was considered for various uranium deposits associated with petroleum deposits. The multiple accretion of uranium ores by repetitive oxidation and leaching of surface deposits was also considered. Radiochemical data indicated that natural leaching and subsequent reduction of uranium in sandstone-type ores may be a relatively recent event. The possible genesis of fracture-controlled, breccia-pipe, and salt-dome uranium deposits is discussed. Geochemical relationships suggest that salt-dome structures as well as fractures transecting permeable carbonaceous sediments may be favorable sites for uranium accumulation. The oxidation of the black uranium-vanadium ores and the formation of carnotite-type deposits are discussed in terms of the relationships between uranium and vanadium mineralogy. Possible sources of uranium in continental sediments are considered. (auth)

24778 AERIAL PROSPECTING EQUIPMENT FOR URANIUM. Santiago F. Pinasco (Comisión Nacional de Energía Atómica, Buenos Aires). p.253-6 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

A transistorized and printed-circuit equipment for aerial prospecting is described. As a detector, a phototube and crystal of five-inch diameter lodged in a forepiece containing the high voltage source for the phototube are used. The electronic circuit consists basically of an amplifier and integrator with a maximum range of 4000 c/sec. (auth)

24779 RESULT OF GEOLOGICAL AND MINING EXPLORATIONS MADE BY THE NATIONAL NUCLEAR ENERGY COMMISSION IN THE REPUBLIC OF MEXICO, WITH REFERENCE TO DEPOSITS OF RADIOACTIVE MATERIALS. Francisco Antúnez Echagaray, Jesús Ruiz Elizondo, and Alejandro Calderón G. (Comisión Nacional de Energía Nuclear, Mexico City . p.257-75 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

Since 1957, the National Nuclear Energy Commission has

carried on a broad and continuing program of geological and mining explorations in search of atomic materials. An area of 11,000 km^2 in 14 states of the country was covered. Of these states, Sonora, Chihuahua, and Durango are the ones that seem to have the most favorable geological conditions for the presence of uraniferous deposits. The exploration work done in various areas of these states makes it seem certain that there are present radioactive mineral reserves conservatively estimated as follows: 200,000 tons of cupro-uraniferous minerals, with an average U_3O_8 content of 0.15%, in the "San Antonio del Cobre" deposit in the municipality of Soyopa, Sonora state; 12,000 tons of primary uranium minerals (pitchblende) with an average U_3O_8 content of 0.2%, in the Granaditas deposit, located in the municipality of Arizpe, Sonora; 300,000 tons of secondary minerals (carnotite and autunite), with an average U_3O_8 content of 0.1%, in the "La Preciosa" deposit in Nazas, Durango state; 30,000 tons of mineral with tyuyamunite, in the deposit, contained in limestone, of the Sierra de Gómez, with an average U_3O_8 content of 0.4%. In addition, in other areas of the states of Sonora, Durango, Chihuahua, Puebla, and Oaxaca, a total of 64,000 tons of radioactive minerals, with an overall average U_3O_8 content of 0.2%, were measured. All together, the reserves of radioactive minerals at present amount to 606,000 tons, with an average U_3O_8 content of 0.1438%. Minor exploration was also carried out in the states of Sinaloa, Coahuila, Zacatecas, Tamaulipas, Nuevo León, Queretaro, Puebla, San Luis Potosí, Oaxaca, Guerrero, and Guanajuato. In Mexico, deposits of radioactive minerals were found in very different geological environments, the rocks containing them ranging in age from Pre-Cambrian to Quaternary. In a very general way, the mineralization of uranium is confined to gneisses and schists in the paleographic Peninsula of Oaxaca and in the Sonora Basin; to calcareous-clayey marine sediments, of Cretaceous age, in the Mexican Geosyncline, which are structurally related to the Peninsula of Coahuila and to the Western Geanticline; to clastic sediments of a continental nature and Pre-Tertiary age, in the eastern slope of the Western Sierra Madre; to continental clastic sediments, Triassic-Jurassic, in the Sonora Basin; and to intrusive and metasedimentary igneous rocks, as well as Tertiary dacites, in the north-central region of Sonora state. The mineralogical aspects and corresponding parageneses are discussed in general terms along with the traps in which radioactive mineralization was found as well as their relations to the general conditions of structure, with consideration of other geological aspects for each uraniferous zone considered. A sketch regarding the present and future prospects for the uraniferous zones of Mexico is included. The mineralogical series of the radioactive elements so far known in Mexico is also presented. Consideration is also given to the presence of deposits of beryllium and lithium, related to intrusive and metamorphic rocks in Sonora and to sedimentary rocks in Coahuila. (auth)

24780 THE PRESENCE OF BERYL AND ITS RELATIONSHIP TO THE GEOLOGICAL CHARACTERISTICS OF NORTHEASTERN MEXICO. Romeo Garza G. and José R. Acevedo. p.277-85 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

There is shown to be a clear genetic relationship between the mineral bodies containing beryl located in the paleozoic Basin of Sonora and the surrounding area and the great Western Geanticline. In that area, the deposits appear as veins of quartz or pegmatite in granitic rocks, in the Sierras of Oposura and Aconchi, or as pegmatite alone emplaced in schists and gneisses, in Sierra Pinta. The geological-structural aspects observed in the various known localities are discussed. The form of the mineral bodies mineralogical association, genesis, and the factors that were involved in the control of the mineralization are described. The importance of beryl deposits and the possibilities of finding other beryliferous areas in similar geological conditions in northeastern Mexico are also discussed. (auth)

24781 PITCHBLENDE IN TERTIARY VOLCANIC ROCKS IN THE AREA OF GRANADITAS, STATE OF SONORA, MEXICO. Francisco Antúnez E. (Comisión Nacional de Energía Nuclear, Mexico City) and Alejandro Calderón G. p.287-300 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

In the Sierra of Santa Rosa, located in the north-central part of the State of Sonora and in the area called Granaditas, uranium mineralization was discovered in a large section of volcanic rocks of the Lower Tertiary. The geological studies of the site, made both on the surface of the ground and inside mining works, made it possible to determine that the mineralization is found emplaced in zones of irregular fracturing and in the lower part of the volcanic section, made up principally of dacitic flows. In the superficial portions of the deposit, the uranium mineralization of the autunite and torbernite types, is found dispersed in the altered zone of dacites and at a depth of only a few meters it appears as pitchblende of a dull black color and sooty texture filling fractures, without any preferential orientation, and in some cases lightly impregnating the encasing rock, in the form of nodules. In the surroundings of Granaditas there are other places with uraniferous mineralization of less importance than that of Granaditas itself (Cuesta del Pastor and 10 de Mayo), presenting analogous geological conditions, with the exception of Anomaly No. 4, located N 18° E and at a distance of 277 meters from the Tiro de Granaditas, called "El Prospector." In this last place the mineralization of uranium is very similar to that found in Granaditas. It is not known whether it represents a continuation of the Granaditas mineralization in that direction or another independent body. Both within the zone of irregular fracturing in which pitchblende was found and in the peripheral zones, some fractures in the form of seams, which varied in size from several millimeters to several centimeters, were found. These seams contained galena, argentite, blende, and native copper in a quartz matrix, generally with little radioactivity. As a result of the mining at Work No. 8, a similar mineralization was found, but generally containing appreciable quantities of uranium in an irregular body, of brecciated structure, which seems to take the form of a "chimney." The petrographic, spectrographic, and x-ray studies made of the Granaditas minerals indicated that the pitchblende is associated with quartz, kaolinite, montmorillonite, and illite and with the elements, lead, zinc, iron zirconium, yttrium, ytterbium, and potassium. (auth)

24782 FURTHER CONTRIBUTION TO THE STUDY OF THE URANIUM-BEARING AURIFEROUS METACONGLOMERATE OF JACOBINA, STATE OF BAHIA, BRAZIL. V. A. Gorsky and E. Gorsky (Comissão Nacional de Energia Nuclear, Rio de Janeiro). p.301-12 of "4th Inter-American Symposium on the Peaceful Application of Nu-

clear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In English)

Uraniferous gold-bearing metaconglomerate of Jacobina, Bahia, was compared with similar deposits in Blind River and Witwatersrand. Material from the Jacobina area was studied. Torbernite was found to be a prominent uranium mineral in the Jacobina gold reef. It occurs disseminated in the ore deposit in a close association with sericite, biotite, chlorite, and muscovite in the interstitial mica-pyrite aggregate, and as inclusions in the quartz pebbles, mostly along cleavage planes, cracks, and microfractures. Torbernite occurs in small amount also in certain quartzites in a large Jacobina area outside the Canavieiras Mine being associated mostly with sericite and independent of any occurrence of uraninite. The discovery of torbernite may modify the problem of the uranium recovery from the Jacobina ore. Uraninite is associated with pyrite and occurs erratically distributed in the interstitial pyrite-micas aggregate as small spots of strong radiation in the autoradiographs but in generally "invisible" as an individual mineral, being finely dispersed in a small volume of pyrite as a peculiar type of intergrowth. Adjacent pyrite is usually altered, soft, and of dull color. Pyrite-micas-chlorite-torbernite-aggregate presents many peculiar characteristics and great variety of the original and transitional forms and pseudomorphs, indicating different generations of micas, their alteration, and influence of the radioactivity. Certain phenomena, as for example, optically anomalous biotite, fine granulated form of micas, altered pyrite, and fine microcrystalline micaceous inclusions in quartz may serve as "indicators" of the presence of radioactive substances in the rock. The value of the indicators was proved not only for Jacobina quartzite but also for certain granites, gneisses, quartzites, and sandstones in a large area of Eastern Brazil. The following heavy, accessory, and secondary minerals were identified in the Jacobina ore: some pyrrhotite, rutile, zircon, hematite, and limonite; little magnetite; rare tourmaline, monazite, and clay of illite group and very rare apatite, epidote, and calcite. (auth)

24783 ARGENTINE URANIFEROUS DEPOSITS WITH SEDIMENTARY CONTROL. P. N. Stipanicic, O. L. Baulies, F. Rodrigo, and C. G. Martínez (Comisión Nacional de Energía Atomica, Buenos Aires). p.313-33 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. I." Washington, D. C., Pan American Union, 1962. (In Spanish)

A description of the Argentine uraniferous deposits in which the mineralization is, to some extent, adapted to some kind of sedimentary control is presented. These deposits are located in certain regions of the country, and most often in certain sedimentary geological formations. Therefore it was considered appropriate to group them into five areas, called "environments," which may each include one basin or more than one superimposed, with generally noncontiguous limits, but with common characteristics from a practical standpoint. The thus differentiated environments: environment of the north; environment of the Pampean Sierras; environment of the Precordillera; Neuquén-Mendoza environment; and environment of Patagonia. For each of these, a stratigraphic chart is given indicating the relative position of the principal mineralized deposits, noting that the ones of commercial value are located principally in the anthrocolithic formations (Paganzo I), especially in those of the Middle and Upper Cretaceous Periods (Diamantian, dolomitic calcareous horizon, multicolor marls, and Chubutian) and also of the Tertiary Period (Cosquín strata). There is given a description of the uraniferous deposits, placing special emphasis on analysis and interpretation of the characteristics that make possible a sedimentary control. An attempt was made to establish a genetic classification of such deposits. The majority of the deposits in volume and concentration of commercial interest in Argentina are epigenetic and especially formed by processes of lixiviation and concentration. As an illustrative supplement, a map is provided of the uraniferous types located so far in Argentina in deposits with sedimentary control. (auth)

24784 4th INTER-AMERICAN SYMPOSIUM ON THE PEACEFUL APPLICATION OF NUCLEAR ENERGY, MEXICO CITY, APRIL 9-13, 1962. [VOLUME] II. (Inter-American Nuclear Energy Commission, Washington, D. C.). 256p. $3.50(IANEC).

Thirty-four papers are presented in Volume II of the Fourth Inter-American Symposium on The Peaceful Application of Nuclear Energy. Topics covered include: chemistry, biology, and education. Separate abstracts were prepared for 33 papers. One paper was previously abstracted for NSA. (M.C.G.)

24785 THE ROLE OF BASIC CHEMISTRY RESEARCH IN A NUCLEAR ENERGY PROGRAM. D. R. Miller (U. S. Atomic Energy Commission, Washington, D. C.). p.3-11 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In English)

Many areas of basic chemistry research are very closely related to nuclear energy programs. Mutual benefits include all of the types normally derived from basic research: acquisition of fundamental knowledge that improves understanding of natural phenomena; the beneficial developments and applications made possible by this improved understanding and increased knowledge; and the training of scientists who are essential to the continued study of basic and applied scientific problems. A broad base of scientific facts, interpretation, and theory about the chemical aspects of nature is essential to the successful developments, applications, and operations required in a nuclear energy program. Areas of particular pertinence include: radiation chemistry; nuclear chemistry; heavy element chemistry; and the effects of isotopic substitution in molecules on the rates and equilibria of chemical reactions. The direct and indirect relation of these and other areas of research to different types of nuclear programs are discussed. Of equal overall importance are the beneficial effects that developments and techniques resulting from nuclear programs have had on the methods and progress of basic chemistry research. Radioactive tracers opened up areas of research and knowledge that were previously unassailable. Nuclear reactors and neutron sources enable the chemist to detect certain elements at lower concentration orders of magnitude than previously was possible. Neutron diffraction methods extended the knowledge of structural chemistry well beyond the borders that were established by the companion techniques of x-ray and electron diffraction. (auth)

24786 THE METHOD OF ABSOLUTE INTENSITY BY X-RAY FLUORESCENCE, FOR QUANTITATIVE DETERMINATION OF URANIUM, LEAD, AND OTHER ELEMENTS. Octavio Cano Corona and Laura Pastrana de Rivera (Universidad Nacional Autónoma, Mexico City). p.13-25 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

Performing elementary quantitative analysis with the use of the fluorescent x-ray spectrograph, is a matter of deriving the concentration of an element in a given sample on the basis of measurement of the intensity of the fluorescence emitted by the atoms of that element. This procedure presents a basic difficulty that seriously limits its application. This is the fact that the fluorescent intensity measured depends not only on the concentration of the element in the sample but also, and to a large extent, on the absorption properties of that sample. An expression called "absolute intensity" was derived, on theoretical bases. This is the product of the fluorescent intensity and the sum of two mass absorption coefficients, the values of which are determined by the use of the x-ray spectrograph. Absolute intensity is proportional to the concentration of the element in the sample, and this relationship is practically independent of the absorption characteristics. This fact was verified experimentally, and its application to the quantitative analysis of uranium is illustrated. Results that imply errors of less than 10% were obtained. (auth)

24787 PRODUCTION OF CHROMIUM-51 OF HIGH SPECIFIC ACTIVITY. José Israel Vargas, Moema Gonçalves Alvarenga, and Elâdio de Almeida Pimentel (Universidade de Minas Gerais, Brazil). p.35-40 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Portuguese)

The low isotopic occurrence of Cr^{50} and the relatively long half life of Cr^{51}, together with the need for obtaining high specific activities, commonly employed in biological and physicochemical applications of this isotope, required the development of special techniques of preparation, by the Szillard-Chalmers effect. Factors such as the temperature of irradiation, radiolitic decomposition, recuperation by ionizing radiations, and the absence of induced parasitic activity condition the yield of separable radioactivity. Results obtained with chromium(III) acetyl-acetonate and with ammonium dichromate employed as target materials are presented. For irradiation times varying from one to seventy hours, at a flux of 3×10^{11} n/cm^2 sec, the enrichment factors decreased exponentially, for both substances, remaining practically constant after approximately forty hours of irradiation. The values of the enrichment factors for chromium(III) acetyl-acetonate and ammonium dichromate respectively, for ten hours of irradiation, were 500 and 10,000, while the retention observed for both substances was the value of 40%. Investigations on the thermic recuperation of the recoil fragments and studies of the radiolysis of both solid crystalline compounds under the effect of pure ionizing radiation from a cobalt source capable of providing a dose variable between 1.0 and 70.0 Mrad, permitted observation of the kinetics of the process. Production trials followed by preliminary biological tests indicate that chromium(III) acetyl-acetonate is suitable for the production of Cr^{51} in low-power reactors. (auth)

24788 KINETICS OF THE ELECTRONIC EXCHANGE REACTION BETWEEN THALLIUM(I) AND THALLIUM(III) IN PERCHLORIC ACID AND IN THE PRESENCE OF ORGANIC ACIDS. Teresa Palma D. and Harold Behrens (Universidad de Chile, Santiago). p.41-6 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

An electron exchange kinetic study is reported on the thallous-thallic system at 6F perchloric acid in the complete absence of anions other than perchlorate. A preliminary study is reported on the spontaneous reduction of thallic ions in 6F perchloric acid; the unimolecular rate constant is reported, in a first approximation as $k = 1.788 \times 10^2$ seg^{-1}. All results are expressed taking into account this reduction. Assuming the correctness of exchange reaction kinetics as overall order two, the constant at 40° ± 0.5°C is $k = [0.693/T_{\frac{1}{2}}(Tl^{3+}) + (Tl^{+})] = 3.30$ f^{-1} day^{-1}. Tl(III) ions were separated by extraction into HCl saturated methyl isobutyl ketone. Tl(I) ions were oxidized by electrolytic oxidation according to Biedermann. Results are presented on the effect of organic acids, acetic and succinic, on the exchange kinetics. These acids tend to reduce the rate of exchange. The rate of this reduction was approximately 1.2[HA]. No difference in this ratio was observed between monobasic and dibasic acids. (auth)

24789 ISOTOPIC EXCHANGE OF Co^{++} AND Cd^{++} BETWEEN THEIR EDTA COMPLEXES AND THE CORRESPONDING CHLORIDES. M. Cendales, M. Casabianca, A. Arroyo, and S. J. Nassiff (Instituto de Asuntos Nucleares, Bogotá, Columbia). p.47-51 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

The half-exchange times for the following homogeneous interchanges were determined: between the cobalt complex of ethylenediaminetetraacetic acid (CoY^{2-}) and the cobalt ion (Co^{2+}) and between the cadmium complex of ethylenediaminetetraacetic acid (CdY^{2-}) and the cadmium ion (Cd^{2+}). In both cases the study was carried out in an aqueous medium. Observation was made of the variation of the velocity of interchange in the ranges of pH that permitted the reacting substances to be kept in solution. The experiments were made at various temperatures. (auth)

24790 MEASUREMENT OF THE DECAY PRODUCTS OF THORIUM IN MEXICO CITY. A. Moreno y Moreno, C. Archundia, A. Nava J., and A. Rodríguez Fraga (Comisión Nacional de Energía Nuclear, Mexico City). p.53-7 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

A previous study of radioactivity of the low regions of the atmosphere of Mexico City (1961) indicated the advisability of modifying the technique of collection of samples in order to determine natural radioactivity. This modification made it possible to observe natural activities characterized by short half lives. The presence of decay products of the Th^{232} chain, starting with Rn and its radioactive descendants is shown. The chain $Pb^{212} \rightarrow Bi^{212} \rightarrow Po^{212}$ was verified by the study of half lives and associated alpha, beta, and gamma emissions. The system of differential equations of the process of collection of activities in the filter was solved, as was that for decay in measuring the radioactivity therein. Coincidence was found between the experimental curves and the theoretical curves obtained by the analytical presentation of the program. (auth)

24791 SYSTEM IN OPERATION FOR THE IMPORTATION, USE, AND APPLICATION OF RADIOISOTOPES IN MEXICO. J. Halvás, R. Sandoval Rebolledo, and R. Ortega Gómez (Comisión Nacional de Energía Nuclear, Mexico City). p.59-61 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

The Radiation Safety Program is responsible for taking protective measures and preventing accidents in the use of radioactive materials. The systems followed to give adequate protection to the public in general and to persons working with and using radioactive materials are described.

The inter-governmental arrangements that made possible the control of these materials, as well as the standards on protection derived from international recommendations and in force throughout the country, are also described. The results obtained through recommendations and by persuasion, as well as through technical assistance given to both government and private institutions, are presented. (auth)

24792 SOME CONSIDERATIONS IN THE ESTABLISHMENT OF RADIATION PROTECTION STANDARDS FOR RADIOACTIVITY IN THE ENVIRONMENT. Donald R. Chadwick (U. S. Public Health Service, Washington, D. C.) and Conrad P. Straub. p.65-72 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In English)

Guidance on total daily intakes of specific radionuclides from all sources averaged over a period of one year, based upon Radiation Protection Guides (RPG), is recommended by the Federal Radiation Council and is given in terms of three ranges of intake. Ranges are specified particularly because of the very wide fluctuation of actual intakes of radioactive materials that would be possible without exceeding the annual dose specified in the RPG. From these daily intakes concentration values in air, water, or food may be calculated for source control where controlled release occurs, but they have limited applicability in environmental controls. Categorization by nuclide and level determines the kinds of action required to provide appropriate protection on the basis of the range in which they fall. Thus, levels falling in Range I may be verified by infrequent sampling, and those in Range II by sufficient monitoring to show that these levels are not exceeded. Where levels fall in Range III extensive monitoring is needed to demonstrate the efficacy of the instituted control measures, thus providing assurance that the levels are reduced to at least Range II. Data are provided indicating the levels that have occurred. Although these have not exceeded the formulated RPG's on the average, possible control measures are discussed with some indication of their potential effectiveness. (auth)

24793 SOLUTION BY ANALOGICAL COMPUTATION OF THE TRANSMISSION AND ABSORPTION OF RADIATION BY DIFFERENT TISSUES. J. Halvás and E. Ortega Espinosa (Comisión Nacional de Energía Nuclear, Mexico City). p.73-5 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

The systems normally used in the evaluation of the transmission and absorption of radiation by different tissues are listed and the various physical factors that are involved in this phenomenon considered. The experimental curves of transmission are presented and the influence of the various absorption coefficients for heterogeneous tissues is considered, along with the mathematical equations that represent them. The computation elements employed in the machine for this type of problem are described, as well as the working equations of those elements, and the programing employed. The solutions found are compared with the experimental data and those obtained by various authors. (auth)

24794 A METHOD TO PROCESS INFORMATION FROM MULTIPLE TRACER EXPERIMENTS. David Yudilevich, P. Martín, and Sergio Bustos (Universidad de Chile, Santiago). p.77-83 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

The use of tracers for the study of dynamics of biological systems is generally made in terms of the "compartmental system analysis." A method, used to study capillary permeability, which consists in comparing concentration versus time curves obtained in the venous blood when a tracer is added in the arterial side of a capillary bed is described. This method compares the dilution curves of a so-called reference tracer and the tracer under investigation. The reference is usually a substance that remains intravascular during one circulation through the given capillary bed. Separation of each radioisotope (Na^{22} and Rb^{86}) in the 60 samples of blood from which the points of the concentration vs. time curves are to be obtained was accomplished by means of gamma spectrometry. Several regions of the energy spectrum were detected simultaneously with counters in parallel. Systems of equations were solved by the inverse matrix method, which systematizes the calculations that are then performed in a Friden SBT desk calculator. Analysis of the standard error was also obtained in the same way. Gamma spectrometry performed in the detection system for I^{131}, Na^{22}, Rb^{86}, and Fe^{59} showed that relative efficiencies are such that they allow separation of these isotopes, in mixtures, by the mathematical methods described. Results are presented of experiments performed in the in situ isolated dog heart to study its capillary permeability to those elements. (auth)

24795 TRANSFER OF RADIOACTIVE CONTAMINANTS IN FOOD CHAINS. D. Beninson, A. Migliori, H. Mugliaroli, and E. Van der Elst (Comisión Nacionale de Energía Atómica, Argentina). p.85-92 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

Results are presented of measurements of Sr^{90} and Cs^{137} coming from radioactive fallout in various links in food chains, together with experimental data on fixation in soil and transfer to vegetation of various nuclides present in radioactive residue. The influence of such parameters as the soil type, vegetation, and weather conditions on the short-term and long-term level of food contamination under various conditions of injection of radionuclides into the biosphere is studied. (auth)

24796 ANALYSIS OF INTRACELLULAR POTENTIALS IN THE GASTRIC MUCOUS MEMBRANE OF THE FROG BY MEANS OF RADIOACTIVE TRACERS. Leopoldo Villegas (Instituto Venezolano de Investigaciones Científicas, Caracas). p.93-9 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

Intercellular electrical potentials were studied in the gastric mucous membrane of the frog, Rana pipiens. In mucous membranes with an extracellular potential of 28.7 mv, the mucous side (m) being negative to the serous side (s), the characteristic intracellular potentials were found to be −49.2 mv in the cells of the superficial epithelium and −17.9 mv in the parietal cells. The asymmetry of the potential recorded in the parietal cells is considered to be related to the mechanisms responsible for the secretion of hydrochloric acid. The common potential (when the secretion of hydrochloric acid is eliminated) of both these types of cells is considered a diffusion potential. The extracellular volume was estimated by using inulin marked with C^{14}. The concentration of free cellular potassium (Kc)

was measured by incubating mucous membranes for varying periods of times in solutions whose potassium was marked with K^{42}. Only 48% of the total cellular potassium, determined by flame spectrophotometry, seemed to be capable of interchanging with the marked potassium when equilibrium is reached in these charge experiments. The difference in the time constants obtained for the exponential relations that link the intracellular potentials recorded with the Kc/Ks and Kc/Km fractions seemed to indicate a difference in the permeability to potassium of the membrane on the two sides of the cell. Consequently, it is suggested that the active processes responsible for the secretion of acid by the gastric mucous membrane are located in the parietal cells. A diffusion potential seemed apparent in all the cells, and the fact that it may be less than that expected according to the gradient of concentrations between the cellular contents and the extracellular medium suggests the presence of other phenomena of diffusion through these membranes. (auth)

24797 BIOMEDICAL TRACER STUDIES WITH THE WHOLE-BODY COUNTER. Howard G. Parker, Thornton W. Sargent, III, Myron Pollycove, Lestra M. Carpe, John A. Linfoot, Hiroshi Saito, and John H. Lawrence (Univ. of California, Berkeley). p.101-8 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In English)

Experience with a human whole-body counter is discussed. The counter, patterned after the design by Marinelli and Miller, consists of a single $9\frac{3}{8} \times 4$ inch NaI(Tl) crystal in a steel-shielded 8×8 foot room. Preliminary studies with Ca^{47} in normal and acromegalic patients are presented. Whole-body counter findings on iron absorption in normal males, and in patients with anemia from a variety of causes, and findings in accidental radioisotope exposures and routine surveys at Lawrence Radiation Laboratory are covered. A variety of preliminary efforts with other tracers in this counter are also given. The usefulness and disadvantages of this type of counter, and the problem of accurate standardization and retention curve analysis are reviewed. (auth)

24798 KINETICS OF IRON. Rômulo Ribeiro Pieroni, Julio Kieffer, and Victorio Maspes (Instituto de Energia Atômica, São Paulo, Brazil). p.109-14 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Portuguese)

The procedures employed in the study of the purification and utilization of iron were studied and the implications of these compared with the results deduced by application of the theory of tracers to implicitly accepted models. It is shown that the usual scheme for the determination of the rate of renewal of plasmatic iron, which considers the disappearance of the tracer from the plasma as a simple withdrawal of it from a compartment is in contradiction with the concomitant determination of the utilization of the iron, since the procedure necessarily involves 100% utilization. The experimental data are reconciled with the inferences that may be deduced from the use of different kinds of models of compartmental distribution of iron. (auth)

24799 ABSORPTION OF FATS MARKED WITH RADIOACTIVE IODINE, PRELIMINARY STUDIES IN GUATEMALA. Alfredo Saravia A., Alberto Viau D., and Miguel A. Pinto (Hospital Roosevelt, Guatemala). p.115-20 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

A study was made of the absorption of neutral fats, employing triolein marked with radioactive iodine, in 35 subjects. The diseases in which defective intestinal absorption occurs are listed. The methods available for the study of absorption of fats are compared and the advantages of the method employed in the study are pointed out. The method for studying the absorption of fats marked with radioactive iodine, employing triolein and oleic acid, is described. The absorption curves of normal individuals in Guatemala and in the United States of America are compared. The absorption curves of normal individuals with good eating habits are compared with those of persons with qualitatively deficient diets. Absorption curves of patients with intestinal parasitism, especially with uncinariasis, are presented and compared with the curves of anemic patients free of intestinal parasitism. (auth)

24800 CAPTURE OF RADIOACTIVE IODINE BY CULTURES OF CHICKEN EMBRYO THYROIDS. Eduardo Penna Franca and Marysa X. O. Musacchio (Universidade do Brazil, Rio de Janeiro). p.121-8 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Portuguese)

A technique was developed that makes possible rapid and precise measurement of the percentage of dose of radioactive iodine that is captured by cultures of fragments of chicken embryo thyroids after a given period of culture in a nutritive medium containing I^{131}. The measurements of radioactivity due to the iodine accumulated in the tissue fragments were made in the culture tubes, in a well scintillator. With this technique, the influence of iodide and propyl thiouracil in I^{131} capture was demonstrated, as was the lack of action of potassium sulphocyanide in the liberation of radioactive iodine already fixed by the glands. The results in cultures of embryo thyroids and hypophyses showed that the influence of the thyrotrophic hypophyseal hormones is more intensive in the liberation of marked thyroidean hormones than in iodide capture. Experiments were conducted to study the influence of purified preparations of thyrotrophic hormones (TSH) (Thytropar of Armour and Ambinom of Organom Ltd.). With these preparations a decrease in the amount of radioactive iodine accumulated in the cultures was observed, indicating stimulation of the discharge of thyroxine and triiodothyronine marked with I^{131}. These marked hormones were identified in the medium by paper chromatography and autoradiography. When the cultures were incubated with I^{131} and after 24 hours the radioactive iodine was removed and varying doses of TSH added, a decrease in the radioactivity in the tissue fragments was observed, varying in proportion to the doses of TSH. This technique was studied in order to ascertain the possibility of transforming it into a fairly simple method for dosage of thyrotrophic hormone (TSH). (auth)

24801 FUNCTIONAL EXPLORATION OF THE THYROID IN PERSONS SUFFERING FROM CHAGAS' DISEASE. Julio Kieffer, Domingos Lomonaco, Rômulo Ribeiro Pieroni, and Helio Lourenço de Oliveria (Universidade de São Paulo, Brazil). p.129-35 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Portuguese)

Taking advantage of the existence of a population group fully studied with regard to the epidemiology of Chagas' disease, in Vila de Coqueiros, São Paulo State, Brazil,

studies were made of certain parameters of the thyroid function for the purpose of better defining the eventual condition of malfunctioning of the gland in this disease, which has long been held to be responsible for thyroid disorders. The human material consisted of a control group and a group of carriers with positive Machado-Guerreiro reaction and other indications of Chagas' disease, including both children and adults of both sexes. The following routine tests were made: capture of radioactive iodine in 6 and 24 hours, plasmatic radioiodoproteinemia (PBI^{131}), and plasmatic iodoproteinemia (PBI^{127}). The tests were repeated, in a statistically significant group, after administration of thyrotrophic hormone in a dose of 5 to 15 U.S.P. units. The results confirmed previous pilot data to the effect that the measurements of capture and of plasmatic iodoproteinemia would be lower than the measurements made on individuals in the control group. The difference is statistically significant. Following the administration of exogenous TSH the capture values significantly increased, and liberation of hormone was appreciable. In view of the results obtained, it was concluded that, as a first approximation, the functional thyroid deficit frequently occurring in a high percentage of persons suffering from Chagas' disease may be interpreted as being due to diminished hypophyseal stimulation. Further research is under way, particularly directed toward the possibility of showing hypothalamichypophyseal anatomic lesions that could be held responsible for the laboratory findings. (auth)

24802 EFFECTS OF PITUITRIN ON CARDIOPORTAL CIRCULATION. Héctor Orrego, Ismael Mena, and Gonzalo Sepúlveda (Universidad Católica de Chile, Santiago). p.137-46 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

The effect of endovenous infusion of 20 units of pituitrin or vasopressin was studied in 13 patients with cirrhosis of the liver (9 with pituitrin and 3 with vasopressin), in one patient with acute fatty liver, and in 3 subjects without liver disease. The effect of the infusion of 10 units of oxytocin was also studied in one patient with cirrhosis. Measurements were made of the cardioportal circulation time, using albumin I^{131}; of the hepatic venous pressure, using a wedged catheter; of the uptake of rose Bengal by the liver, of the cardiac output, and of the circulatory volume. In one case, O_2 pressure and saturation were measured in the blood from the hepatic vein. In 12 cirrhotics in whom the cardioportal circulation time was studied, the infusion of pituitrin or vasopressin produced a very significant prolongation. The time effect was obtained in the patient with acute fatty liver and in the subjects with normal livers. Oxytocin produced no change in cardioportal circulation time. In 5 patients in whom the wedged pressure in the hepatic vein was measured, it fell after infusion of pituitrin or vasopressin, but the decrease was slight and the minimal values were reached after time intervals that varied greatly. In the patient in whom the O_2 tension and saturation were measured, they decreased markedly after pituitrin infusion. Rose Bengal uptake increased in 9 cirrhotics and decreased in one. Cardiac output and circulatory volume increased in most cases, but their variation did not correlate with the hemodynamic changes in the portal territory. Vascularity was maintained in all cases. No differences were observed between the action of pituitrin and of vasopressin. The significance of these changes and their possible causes is discussed. (auth)

24803 HEMATOLOGICAL CHANGES BY EFFECT OF IONIZING RADIATION. R. González Constandse and J. E. Mejía Laguna (Comisión Nacional de Energía Nuclear, Mexico City). p.147-51 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

A study was made of thirty patients who were given treatment with ionizing radiations because they had cervicouterine cancer in various clinical stages. In all cases, hematological studies were made before the beginning of treatment, using capillary blood samples for the cytological study, thus avoiding the possible changes that might occur in the cells by effect of anticoagulant. For the other determinations in hematic biometry venous blood was used, employing the Paul Heller mixture as anticoagulant. Once the treatment was begun, controls were established at every 1000 r of air doses until conclusion of the treatment. The doses the patients received are given, as well as the cytological changes observed, which, in general, corroborate the findings of experimental work. It is reported that the tissue that shows greatest sensitivity is the lymphocytic tissue. The first thing that happens is the decrease in the absolute count of its elements, the lymphocytes; as the doses progressed, morphological changes were observed, characterized by vacuolization of the nucleus, bilobulation of it, or the appearance of pycnotic spots in the cytoplasm. Also indicated are the changes observed in the other series: granulocytes, monocytes, platelets, and elements of the red series, and observations are made not only of the qualitative but also of the quantitative changes. An attempt was made to establish in schematic form the relationship between doses and changes observed in accordance with their appearance in the course of treatment. (auth)

24804 EFFECT OF IONIZING RADIATION ON THE BLOOD COAGULATION SYSTEM. R. González Constandse and C. Armendariz Carrillo (Comisión Nacional de Energía Nuclear, Mexico City). p.153-6 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

Fifteen female patients with cervicouterine cancer in stages I, II, III, or IV who were under radiotherapy treatment were studied. In all cases the following determinations were made: bleeding time; coagulation time of recalcified plasma; prothrombin time; blood-platelet count; and generation of thromboplastin. This group of tests was made before, during, at the end of, and ten days after the treatment. At the same time, in the stage prior to treatment, tests of liver function were made for the purpose of setting apart any additional malfunction or disease that might interfere in any way with the blood coagulation system. The results obtained are given and, even though they coincide with the findings of other authors in that the most frequent cause of hemorrhage in radiated patients is principally due to secondary thrombocytopenia, in the group studied no symptomatic hemorrhages attributable to thrombopenia were found. However, in some patients alteration was observed in the generation of thromboplastin, a defect that was corrected when the platelets of the patient were replaced in the system by platelets of the normal control subject. This led to the supposition of the probable existence of a temporary thrombocytic enzymatic defect. (auth)

24805 PROBLEMS OF DOSIMETRY AND CLINICAL APPLICATIONS OF COBALT-60 PEARLS IN MEXICO. M. García Sainz, J. Halvás, and F. Cabré Parra (Hospital de Oncología, Mexico City). p.157-60 of "4th Inter-

American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

A study was made of the physical aspects and clinical problems of the use of radioactive cobalt pearls made of metallic cobalt and with a gold covering approximately 50 microns thick, which in addition to protecting the cobalt against corrosion filters the beta rays it emits. The diameter of the pearls is 6 mm and they are perforated so that they can be threaded, and their activity is on the order of 4 to 5 millicuries. Theoretical consideration is made of clinical dosimetry, and the results of measurements made using plastic pouches are given. The application made of these pearls of radioactive cobalt was basically for the treatment of carcinoma of the uterine body and to pack natural or surgical cavities. Some typical cases are presented. (auth)

24806 THE RENOGRAM AS A TOOL FOR EVALUATING PATIENTS WITH CANCER OF THE CERVIX UTERI. Sergio Irizarry (Univ. of Puerto Rico and I. González Martínex Oncologic Hospital, San Juan) and Angel Luis Rodríguez Rosado. p.161-7 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In English)

The value of the isotope renogram in the evaluation of the patency of the urinary tract and renal function in patients with cancer of the cervix was assessed. It is of importance for the surgeon to know the status of the patency of the urinary stream. The renogram differentiates a nonfunctioning kidney from a blocked kidney. In this study patients with advanced pelvic cancer, preferably cancer of the cervix, stage III, were selected. Hipputope I^{131} (Orthoiodohippuric acid I^{131}) was injected intravenously in a dose of 1 μc per 5 kilograms of body weight. The radioactivity levels were followed up over each renal area for half an hour using surface scintillation counters. The activity was measured with ratemeters connected to strip chart recorders. Twenty four patients were examined, of which 18 had carcinoma of the cervix, stage III; 15 had normal renal function and excretion of urine as reflected by both the isotope test and the intravenous pyelogram. Eight patients had abnormal function in both tests. In two patients the tests were at variance; one was normal by the renogram but was abnormal by the urogram, and the other showed the reverse. There are four cases in which the renogram gave more information as to the nature of the renal status: two cases showed irreversible kidney damage unilaterally with reversible damage in the contralateral kidneys, and both cases showed hydronephrosis by the x-ray tests. In two other cases the renogram shows absence of excretion and renal function whereas the pyelogram shows absence of renal function. There was complete correlation between the 15 renograms and pyelograms but one out of eight renograms failed to correlate with the intravenous pyelogram and vice versa. The lesions of the urinary systems may be of three types in these cases: excretory, secretory, or both. Comparison of the information given by the renogram with the intravenous pyelogram led to the belief that the renogram may be of value in judging both the patency of the ureters and the integrity of function of the renal parenchyma. The frequency of ureteral compression was two fifths in the group of stage III carcinoma of the cervix uteri. The renogram appeared as good as the intravenous pyelogram in demonstrating disturbances of renal excretion and superior for renal secretion. For the sick cancer patient this test seems to be more suitable as a screening procedure for abnormalities of the renal apparatus because it can be done more easily. (auth)

24807 IMPORTANCE OF THE RADIORENOGRAM IN CERVICOUTERINE CANCER. Peter L. Eberstadt, Victoria González del A., and Rodolfo Díaz Perches (Comisión Nacional de Energía Nuclear, Mexico City). p.169-77 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

Twenty-five patients with cervicouterine cancer are studied, the majority of them being in the advanced stages and consequently suffering uterine compressions. An effort was made to correlate the findings of the radiorenogram with the clinical data of exploration, blood chemistry, cystoscopy, and excretory urography, repeating the radiorenogram periodically, or each time that any of these studies indicates a change from the previous one. In some cases the renogram showed changes in normal functioning, before these were suspected on the basis of the other studies mentioned. (auth)

24808 STUDIES OF THE GENETIC EFFECTS OF IRRADIATION DURING THE PERIFERTILIZATION STAGES OF DROSOPHILA MELANOGASTER. R. M. Valencia and J. I. Valencia (Atomic Energy Commission, Argentina and Univ. of Buenos Aires). p.179-84 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In English)

Stage 14 oocytes, recently fertilized eggs; and early embryos were found to be about equally sensitive to an x-ray dose of 500 r. All gave about 60% embryonic mortality. Mature sperm, on the other hand, irradiated with the same dose, conferred a relatively low (10%) mortality upon the eggs fertilized by it. This difference suggests that the major cause of death in irradiated eggs is not chromosome breakage. The damage must, nevertheless, be nuclear. It is proposed that a key biochemical entity, closely associated with the genetic material, could be the target. The lack of difference in mortality among the three egg stages probably indicates that 500 r is a saturating dose for the event concerned in the death of these cells. (auth)

24809 THE EFFECT OF IONIZING RADIATIONS ON THE BIOLOGY AND ECOLOGY OF RHODNIUS PROLIXUS, THE PRINCIPAL VECTOR OF S. CRUZI IN VENEZUELA. J. C. Gómez N., J. C. Gallimore, J. Fernández M., and A. Gross (Instituto Venezolano de Investigaciones Científicas, Caracas). p.185-93 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

The use of radiations and radioactive isotopes in the search for a solution to the problem created by R. prolixus as the principal vector of Chagas' disease in Venezuela, which threatens 2,800,000 people in that country, is described. At present the campaign against R. prolixus is being approached in two ways: by construction of houses, and by treatment of houses with insecticides. The first measure is slow and the second, in addition to being expensive, presents risks to the operators and to domestic animals, since the insecticides effective against R. prolixus are highly toxic. Because of this, a study was started of the biology and ecology of R. prolixus, with a view of obtaining results that would make possible a more effective method to be used against that insect. In addition, the possibility of applying the method of control based on the in-

troduction of sterile males in a population that it is desired to eradicate is being investigated. In irradiating males of R. prolixus it is observed that sterilization occurs with doses of more than 10,000 r, and that the motility and longevity of the insect are significantly reduced by exposures of 10,000 r and 40,000 r, respectively. Data are presented that show, in the individuals descended from irradiated males, mutations that prevent normal development of the nymphs. The use of irradiated males also served to establish the absence of a "copulatory stoppage" in the female of R. prolixus. In the ecological studies Co^{60} was used for labeling. Results were obtained that show the distribution of R. prolixus in and outside houses. These results suggest changes in the concept that was held about the behavior of this vector in Venezuela. The report presented points out the contribution that ionizing radiations can make in the systematic and detailed study of R. prolixus. (auth)

24810 THE ACTION OF MUTAGENIC AGENTS ON BARLEY SEEDS. C. F. Konzak and R. A. Nilan (Washington State Univ., Pullman). p.195-200 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In English)

Studies on the influence of physical and chemical factors on mutagen-induced damage in barley seeds are providing a sound experimental basis for understanding the mechanisms responsible for various kinds of mutagen-induced damage in cells. These studies established that moisture, oxygen, post-radiation storage, pre- and post-radiation temperature, and post-radiation heat shock greatly modify radioinduced damage. In the light of physical evidence provided by electron spin resonance techniques, the biological effects obtained are convincing experimental evidence for the concept that at least a part of radioinduced damage is mediated in cells by way of mechanisms in which induced free radicals may play a critical role. Comparative experiments with the chemical mutagenic agents diethyl sulfate and ethyl methane sulfonate show that these chemicals can produce extremely high yields of mutations but very low yields of gross chromosomal aberrations. These results suggest that mutations and chromosomal aberrations originate independently even though they may be concomitantly induced by radiation and other chemical agents. (auth)

24811 STUDIES ON THE ANGUSTIFOLIA MUTANT OF COFFEE INDUCED BY GAMMA RADIATION IN R_1 GENERATION. Jaime Cevallos V. (Instituto Interamericano de Ciencias Agrícolas, Turrialba, Costa Rica). p.201-9 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

Studies were carried out on the angustifolia mutant induced by gamma radiation in the R_1 generation in six lines of coffee: "Local Typica," "Padang," "Philippinean," "Local Bourbon," "Salvadorean Bourbon," and "Bourbon Segregated from Murta." The first three lines belonged to "Typica" cultivar and the latter three to "Bourbon." It was found that when the seeds were irradiated with a series of radiation doses, some common characteristics of response were found: a high frequency of angustifolia mutants was induced in the R_1 generation, and the dosage-frequency relationship was exponential. There was no statistical difference in the induced angustifolia frequencies among the three lines of coffee belonging to the "Typica" cultivar; nor was there a statistical difference among the three lines of "Bourbon." However, there was a significant difference in the induced angustifolia frequency between "Typica" and "Bourbon" cultivars; the induced frequency in "Typica" being higher. It was postulated that the induction of angustifolia mutants in the R_1 generation by radiation is due to the result of two-hit chromosomal aberrations. The close association found between pollen sterility and the angustifolia mutation lent support to this assumption. The angustifolia mutants were characterized by having smaller and thicker leaves as compared with those of normal plants. From comparative histological studies, it was concluded that: the narrower width of the angustifolia leaves was due to a reduction in the number of cells, and the greater thickness of the angustifolia leaves was due to a greater length of the palisade cells and to a higher number of cellular layers in the spongy tissue. Histological studies on the angustifolia mutants appearing spontaneously or radiation-induced showed that the same mechanism described above was operating in the production of angustifolia leaves. (auth)

24812 POSSIBILITIES OF ERADICATION OF THE MEDITERRANEAN FRUIT FLY, CERATITIS CAPITATA (WIED.) FROM CENTRAL AMERICA BY GAMMA-IRRADIATED MALES. Kamta P. Katiyar (Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica). p.211-17 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In English)

The Mediterranean fruit fly was first noticed in Costa Rica in 1955, and since that time has spread throughout the country, and into some parts of Nicaragua. It is a source of infestation not only to the neighboring countries, since, because of air travel, it could easily become again a serious economic threat in the U. S. A., where the citrus industry is highly developed. The technique of irradiating insects to sterilize the males, or to induce mutant lethals, is not new and has been used with great success in the field. The mass production of the Mediterranean fruit fly can be done in the laboratory within limits that are economically feasible. Owing to local topography, and to the fact that at certain seasons the natural population density of this fly is extremely low, the chances of successful control of this pest by mass releases of gamma-irradiated males seem to be excellent. Preliminary results using the existing Cs^{137} irradiator in the gamma field showed that when pupae about 85 to 90% developed are irradiated with 10 to 13 kiloroentgens, sterility can be induced in adults without any deleterious side effects on longevity and mating. The field experiment will be done using a pool irradiator that was built. The dispersal habit and longevity of this fly will be studied in nature by releasing radioisotope-labeled adults. P^{32} was used for labeling adults successfully by mixing the isotope in both the larval rearing medium and in the adult food, but the latter method was more effective and cheaper. (auth)

24813 STUDIES MADE WITH PHOSPHATE FERTILIZERS "LABELLED" WITH PHOSPHORUS-32. L. Neptune Menard and E. Malavolta (Centro de Energia Nuclear na Agricultura, São Paulo, Brazil). p.219-23 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Portuguese)

Several experiments were carried out using phosphate fertilizers labeled with P^{32} (superphosphate, bicalcium phosphate, basic Thomas slag, bonemeal, and natural phosphates of various origins). The "A" value of a red soil derived from basalt was determined. The original technique was modified in order to use a large number of

rice seedlings growing in a small amount of soil treated with various phosphates; the soil was cultivated three times in this way, which made it possible to follow the variations in the "A" value and in the availability of fertilizers. The "A" value was larger when the fertilizer was less soluble; the "A" values increased from the first to the last harvest. Absorption of fertilizer decreased from the first to the last harvest. An analogous experiment was carried out using Aspergillus niger instead of rice. There was little correlation between the results obtained in the two experiments. However, good correlation was noted when irradiated phosphate fertilizers were used. It was concluded that the technique summarized can be useful for determining "A" values. This is not true, however, when A. niger is used to extract P from the soil and the fertilizers. (auth)

24814 RELATIONS BETWEEN A NATIONAL LABORATORY AND THE ACADEMIC COMMUNITY. Frank E. Myers (Argonne National Lab., Ill.). p.227-35 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In English)

Argonne National Laboratory supports various activities in education and training, research, and university cooperation. Included are opportunities for employees to work toward degrees in science and engineering at various universities, and for students and faculty members from universities to gain research experience. Also, Argonne's International Institute of Nuclear Science and Engineering, in addition to offering advanced training and research opportunities to engineers and scientists from the U. S. and abroad, opens its instructional laboratories to many advanced engineering students. Although Argonne confers no degrees, graduate students often do thesis research at the Laboratory under the joint supervision of a professor and a member of the staff. Postdoctoral research appointments are available for Ph.D.'s and appointments at senior levels are available for professors and other scientists and engineers. In addition, many professors pay short visits to the Laboratory to participate in seminars and symposia, or to serve on the formal committees that review the Laboratory's programs and policies. Conversely, members of the Laboratory's staff are frequently released temporarily from their duties to conduct seminars or symposia, to accept fellowships, or to accept visiting professorships at universities. Other cooperative programs for students and faculty members were established with a group of liberal arts colleges, and with an association of universities and research institutes. All of these programs are described, and suggestions for improvement are continually being sought. (auth)

24815 BASES AND PRESENT DEVELOPMENT OF THE PROGRAM OF EDUCATION IN NUCLEAR SCIENCES IN MEXICO. Augusto Moreno y Moreno (Comisión Nacional de Energía Nuclear, Mexico City). p.237-40 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

The bases of the education program in relation to the scientific, technical, and industrial needs in Mexico are presented. The international assistance received is pointed out. An explanation is given for the collaboration between universities and institutes and the National Nuclear Energy Commission (CNEN). The achievements made in construction of electronic equipment for use in teaching and research, and also the various types of instruments manufactured by the CNEN for this purpose, are described. The results obtained in the courses sponsored by the CNEN on the following subjects are discussed: basic techniques for radioisotopes and nuclear instrumentation, nuclear medicine, medical applications of radioisotopes, and radiobiology. The results of the course in nuclear engineering given by the National Polytechnical Institute are also discussed. (auth)

24816 THE TEACHING OF NUCLEAR ENGINEERING IN MEXICO. Víctor Flores Maldonado, Arnulfo Morales y Amado, and Leopoldo García-Colín S. (Comisión Nacional de Energía Nuclear, Mexico City). p.241-3 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

In Mexico, economically usable carboniferous reserves are very limited. Petroleum, however, does exist in appreciable quantities. Taking into account the development of national industry and population growth, however, it is necessary to have an effective plan to regulate the use of petroleum, which is so important as a fuel for vehicles and in the petroleum chemical industry. The development of nuclear energy and its applications was slow. The establishment in 1961 of graduate courses in nuclear engineering at the Advanced School of Physics and Mathematics of the National Polytechnical Institute was intended to make up for this deficiency. Training in nuclear engineering involves problems relating to the liberation, control, and utilization of energy produced in nuclear reactors. The teaching program includes courses dealing with these problems and covering the knowledge needed by nuclear engineers. A group of elective courses is also included, which permits the student to choose a field of specialization in accordance with his abilities, with a view to meeting the needs of the country. (auth)

24817 LABORATORY FOR THE TEACHING OF ATOMIC AND NUCLEAR PHYSICS. F. Alba, J. Flores, and L. Vater (Universidad Nacional Autónoma, Mexico City). p.245-50 of "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy. Vol. II." Washington, D. C., Pan American Union, 1962. (In Spanish)

The workshops of the Faculty of Sciences and of the Institute of Physics of the National University of Mexico currently manufacture equipment needed for training students and for conducting experiments in the field of atomic and nuclear physics. It is shown that it is possible, with a modest mechanical and electronics workshop and with a relatively small amount of money, to make scientific equipment that can be used in teaching and research in these fields. (auth)

BIOLOGY AND MEDICINE

General and Miscellaneous

Refer also to abstracts 24794, 24806, 24807, and 24813.

24818 (ACRH-18) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Leon O. Jacobson, ed. (Argonne Cancer Research Hospital, Chicago). Sept. 1962. Contract AT(11-1)-69. 165p.

Research progress at Argonne Cancer Research Hospital is reported in 23 papers. Separate abstracts were prepared for 12 papers. Eleven papers were previously abstracted for NSA. (M.C.G.)

24819 (ACRH-18(p.13-20)) DYNAMICS OF THE STEM CELL COMPARTMENT. C. W. Gurney (Argonne Cancer Research Hospital, Chicago).

An erythropoietin tolerance test was devised for the study of reticuloendothelium stem cells. The test animal is the polycythemic mouse, prepared by transfusion. Various stimuli, either separately or in combination, were applied to the stem cell compartment and the effect was measured in terms of reduction of the anticipated response to a standard dose of erythropoietin. (M.C.G.)

24820 (ACRH-18(p.21-9)) INFLUENCE OF SEVERAL HORMONES ON ERYTHROPOIESIS AND OXYGEN CONSUMPTION IN THE HYPOPHYSECTOMIZED RAT. J. W. Fisher and J. J. Crook (Argonne Cancer Research Hospital, Chicago).

The erythropoietic effects of several hormones, some of which are known to be released in hypoxia, were studied. The hypophysectomized rat was selected as the test animal because of its known sensitivity to hormonal treatment. In an attempt to relate the ratio of tissue metabolic oxygen demand and supply with erythropoiesis, the influence of these compounds on oxygen consumption was determined. The substances studied were adrenocorticotrophic hormone, growth hormone, thyroid stimulating hormone, 3,5,3′-triiodothyronine, angiotensin, adrenocortical extract, corticosterone, 11-dehydrocorticosterone, 17-OH corticosterone, aldosterone, and testosterone. Effects of hormones on Fe^{59} incorporation in red cells were measured. The hormones stimulated erythropoiesis. (M.C.G.)

24821 (ACRH-18(p.32-42)) FURTHER PURIFICATION OF SHEEP PLASMA ERYTHROPOIETIN. E. Goldwasser, W. F. White, and K. B. Taylor (Argonne Cancer Research Hospital, Chicago).

Purification of sheep plasma erythropoietin, the hormone that stimulates the formation of red blood cells, is discussed. An overall purification of about 400-fold was obtained by combined ion-exchange purification methods, with a recovery of about 35% of the starting activity. When used to immunize rabbits, the resulting erythropoietin fraction proved to be antigenic, giving rise to easily detectable precipitins. Neither precipitating nor neutralizing antibodies toward the active erythropoietin were demonstrated, however. Chemical properties of erythropoietin fractions are discussed. (M.C.G.)

24822 (ACRH-18(p.46-62)) ANTIBODY FORMATION IN THE RAT. THE AGGLUTININ RESPONSE TO PARTICULATE AND SOLUBLE FORMS OF FLAGELLA PROTEIN FROM SALMONELLA TYPHOSA. F. W. Fitch and J. Winebright (Argonne Cancer Research Hospital, Chicago).

The immune response of rats was investigated. The antigen selected was a purified flagellar preparation from Salmonella typhosa. The material was prepared in both particulate and soluble forms. The two forms are closely related chemically but differ markedly in physical properties. The effect of variation in dose and route of injection of the flagella in intact and splenectomized rats was studied both after an initial antigen injection and a second antigenic stimulus given 4 weeks later. The spleen appeared to play less of a role in the agglutinin response to soluble flagellin than to particulate flagella. The intravenous route of injection gave the highest level of circulating antibody, the intraperitoneal route came next, and the subcutaneous route was the lowest. (M.C.G.)

24823 (ACRH-18(p.68-75)) TECHNIQUES FOR PARAMETRIAL IRRADIATION USING COBALT-60. L. H. Lanzl, H. E. Brizel, and E. M. Duthorn (Argonne Cancer Research Hospital, Chicago).

Three Co^{60} techniques of external irradiation are compared with respect to adequate coverage of tumor, particular application of each technique, and sparing of uninvolved normal structures. The techniques were evaluated in part on relative depth dose measurements determined by exposing a phantom containing x-ray film to the appropriate gamma beams of either fixed or moving fields. It was concluded that if rotational Co^{60} is available, there should be no real necessity to employ straight opposing ports for external irradiation to cancer of the cervix. The 60° sector seemed indicated when the various factors for intracavitary or transvaginal irradiation are optimal and only the structures lateral to the paracervical areas need supplementary treatment. The 85° sector is shown to be suited for cases in which significant pre-radium x-ray therapy to midline structure is necessary. (M.C.G.)

24824 (ACRH-18(p.76-88)) PRELIMINARY OBSERVATIONS ON THE USE OF SIX-HOUR Tc^{99m} AS A TRACER IN BIOLOGY AND MEDICINE. P. V. Harper, G. Andros, and K. Lathrop (Argonne Cancer Research Hospital, Chicago).

Investigation of the metabolism of Tc^{99m} administered intravenously to humans and experimental animals as TcO_4^- revealed that the administered material is probably diluted at first in the extracellular space, and later slowly penetrates into the intracellular space. About 1% of the injected dose localizes in the thyroid gland and about 25% in the stomach. The localization is inhibited by I^- and ClO_4^-. About one-half the injected material is excreted by human subjects in 48 hours. The short half life (six hours), ready availability, and desirable radiation characteristics, make possible applications in thyroid scanning and radiocardiography, with greatly reduced radiation dosage to the patient. (auth)

24825 (ACRH-18(p.99-100)) MODIFICATION OF RADIATION RESPONSE OF TISSUE BY COLCHICINE. PRELIMINARY CLINICAL EVALUATION. M. L. Griem and F. D. Malkinson (Argonne Cancer Research Hospital, Chicago).

The effects of colchicine on radiation response of malignant tumors were studied. Fifty patients were treated. Results are presented in tabular form. Most favorable responses were obtained in adenocarcinoma of the stomach, pancreas, colon, and lung. (M.C.G.)

24826 (ACRH-18(p.101-4)) A NEW SIMPLIFIED METHOD FOR PERFUSING DOG SKIN. K. Adachi and D. C. Chow (Argonne Cancer Research Hospital, Chicago).

The medial aspect of the thigh in the dog was perfused without complete removal of the skin flap and using the animal's own blood from the femoral artery as the perfusion fluid. Preparation of shunts from the femoral artery and vein to the main cutaneous branches of the saphenous artery and vein is described. Methylene blue solution was used to test the extent of the perfused area. It was found that subcutaneous tissue and musculature are not stained and that the perfused skin area extends over the anteromedial aspect of the whole thigh. (M.C.G.)

24827 (ACRH-18(p.105-13)) DEOXYRIBONUCLEIC ACID MICRODETERMINATION IN HUMAN EPIDERMIS. P. Santoianni and S. Rothman (Argonne Cancer Research Hospital, Chicago).

A method for estimation of desoxyribonucleic acid (DNA) in minute amounts of epidermis was developed using the indole reaction. A yellow color is formed when DNA is heated with indole in HCl solution. Results obtained by using the method on extracts, rat skin, and human skin are presented in tabular form. (M.C.G.)

24828 (ACRH-18(p.134-7)) STEROID PYROGEN STUDIES IN LABORATORY AND DOMESTIC ANIMALS. R. H. Palmer, B. Ratkovits, and A. Kappas (Argonne Cancer Research Hospital, Chicago).

Studies were made on the injection of pyrogenic steroids in various experimental animals. Results indicated that several steroid metabolites shown to be pyrogenic in man consistently failed to induce significant temperature elevation in a wide variety of laboratory and domestic animals despite their administration by intramuscular, intravenous, or intrathecal injection in large doses. The steroid metabolites were derived from endogenous adrenocortical and gonadal hormones. (M.C.G.)

24829 (ACRH-18(p.145-7)) PARATHYROID HORMONE AND WHOLE BODY OXIDATION OF GLUCOSE, PYRUVATE, AND CITRATE BY THE INTACT RAT. J. L. Spratt and Gar Bo Ho (Argonne Cancer Research Hospital, Chicago).

The whole-body oxidation of glucose following the administration of parathyroid extract was investigated. Citrate and pyruvate oxidation was also studied. Tracer techniques were used. No significant effects of parathyroid extract were observed. (M.C.G.)

24830 (ACRH-18(p.155-60)) BIOCHEMICAL STUDIES ON SPONTANEOUS CARCINOGENESIS: IN VIVO EFFECTS OF HORMONAL CHANGES ON C3H MICE BEARING HORMONE-DEPENDENT MAMMARY CARCINOMA. G. T. Okita and E. A. Ezz (Argonne Cancer Research Hospital, Chicago).

The effects of ovariectomy and administration of testosterone and estradiol on the oxidation of C^{14}-labeled glucose in control, precancerous, and tumor-bearing mice. Ovariectomy and testosterone decreased the oxidation of glucose-6-C^{14} but had little or no effect on glucose-1-C^{14} metabolism. Estradiol inhibitory effects were much greater in precancerous and tumor mice. Results indicated a biochemical correlation between mammary tumor carcinogenesis and hormonal influences on mice. (M.C.G.)

24831 (AED-C-12-03) AUSGEWÄHLTES SCHRIFTTUM NACH SACHGEBIETEN. OSTLITERATUR DER KERNWISSENSCHAFTEN. RADIONUKLIDE IN BIOLOGIE UND MEDIZIN. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Bibliographic Review of Selected Subjects. Eastern Literature on Nuclear Science. Bibliography on Radionuclides in Biology and Medicine). Benno Ensslen and Rolf Paul (Kernforschungsanlage, Jülich, Germany). Sept. 15, 1962. 180p.

References (604) are given to reports, journals, books, and translations published from 1955 through 1961. Separate author and report number indexes are included. (P.C.H.)

24832 (BNL-6960) A MATHEMATICAL MODEL FOR THE DISTRIBUTION OF LENGTHS OF CHROMOSOMAL DEFICIENCIES INVOLVING A SPECIFIC LOCUS. K. H. Thompson (Cornell Univ., Ithaca, N. Y. and Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 13p.

A mathematical model is presented for use in determining the distribution of lengths of chromosomal deficiencies involving a specific locus. The model assumes that the loss of a chromosomal segment is based solely upon the location of two chance breaks in the chromosome and not upon the distance between the two breaks. The mathematical model is also applicable to situations where the locus is bounded at an unknown distance on each side by an essential locus. (C.H.)

24833 (ORNL-3115) THERMOLUMINESCENCE SPECTRA AND ACTIVATION ENERGIES FOR AROMATIC AMINO ACIDS, TRYPSIN, AND SPORES OF BACILLUS MEGATERIUM. C. J. Weinberg, J. G. Carter, D. R. Nelson, and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). June 21, 1963. Contract W-7405-eng-26. 127p.

Thesis submitted to Graduate School of Vanderbilt Univ., Nashville.

The theory of thermoluminescence is reviewed. The spectral distribution of thermoluminescence and the activation energies associated with peaks of the glow curves were determined for samples of aromatic amino acids, trypsin, and spores of Bacillus megaterium irradiated by a Co^{60} γ source. All of the substances, except phenylalanine, exhibited a readily observable long-lived glow that persisted up to at least 2 hr following irradiation. Possible reaction mechanisms in the production of thermoluminescence in biological materials are discussed. (C.H.)

24834 (TID-18760) HEMOGLOBIN SYNTHESIS IN NUCLEI OF AVIAN ERYTHROCYTES. O. A. Schjeide, G. V. Alexander, J. P. Okunewick, C. R. Carmack, E. N. Carlsen, and T. G. Hennessy (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [Apr. 18, 1963]. Contract AT(04-1)-Gen-12. 26p.

Circulating red cells from chicken embryos display a remarkable capacity for uptake of radiophosphorus (P^{32}) into nuclear RNA, as well as uptake of radioiron (Fe^{59}) into hematin, as compared to cells from chicks and adults. Hematin appears to be synthesized in the nucleus of the circulating red cell which is then passed to the cytoplasmic portion of the cell. (auth)

24835 MAMMALIAN CHROMOSOME CYTOLOGY. Ernest H. Y. Chu (Oak Ridge National Lab., Tenn.). Am. Zoologist, 3: 3-14(Feb. 1963).

Developments in mammalian cytology are presented. Human and mouse cytogenetics and the chromosome cytology and evolution of primates are reviewed. 89 references are included. (P.C.H.)

24836 CYTOLOGICAL CONTRIBUTIONS TO MAMMALIAN GENETICS. W. J. Welshons (Oak Ridge National Lab., Tenn.). Am. Zoologist, 3: 15-22(Feb. 1963).

Discoveries in cytology that have led to the clarification of genetic phenomena are reviewed. Mammalian sex determination, male antigen in mice, meiotic cytology, variegation in Drosophila and mice, dosage compensation, and variegation and dosage compensation in mammals are discussed. (P.C.H.)

24837 GENES AND DEVELOPMENTAL PATHWAYS. E. B. Lewis (California Inst. of Tech., Pasadena). Am. Zoologist, 3: 33-56(Feb. 1963).

A cytogenetic study of the bithorax mutants of Drosophila melanogaster suggests that the level of development attained by certain body segments in the organism is controlled by a cluster of five closely linked genes or pseudoalleles. At least three of the five genes appear to have specific functions that can be accounted for in terms of three hypothetical bithorax substances. At the same time the functioning of all of the genes of the cluster is closely coordinated. The way in which the action of the bithorax genes is regulated during development can be formally understood if it is assumed that a posterior-anterior gradient exists in the concentration of a relatively nondiffusible substance that serves as the initial substrate (sequential reaction model) or as the inducer (operon model). (P.C.H.)

24838 DEVELOPMENT AND GENETICS OF PATTERNS. Heinrich Ursprung (Johns Hopkins Univ., Baltimore). Am. Zoologist, 3: 71-86(Feb. 1963).

Developments in the problem of differentiation are discussed, along with the role of genes in the process. Consideration is given to differentiation in Drosophila. The embryological and mathematical approaches are also discussed. (P.C.H.)

24839 CYTOGENETICS AND DEVELOPMENTAL GENETICS COURSE—A POSTSCRIPT. R. C. von Borstel (Oak Ridge National Lab., Tenn.). Am. Zoologist, 3: 87-95(Feb. 1963).

A brief summarization of developments in mammalian cytogenetics, gene action during development, and cell clones and pattern formation is presented. (P.C.H.)

24840 VARIOUS ASPECTS OF OCULAR THERAPY WITH STRONTIUM-90 APPLICATORS. R. Bilucaglia and A. E. Placer. Arch. Oftalmol. (Buenos Aires), 36: 210-15(Aug. 1961).

The use of Sr^{90} for local irradiation of eye tumors is described. (H.H.D.)

24841 INVESTIGATIONS ON THE INFLUENCE OF HAEMIN AND HAEMIN DERIVATIVES ON THE NUCLEAR-MAGNETIC RELAXATION OF WATER PROTONS. W. Scheler (Ernst Moritz Arndt-Universität, Greifswald, Ger.). Biochim. Biophys. Acta, 66: 424-33(May 21, 1963). (In German)

Hemin, hemin derivatives, and ferric hemoproteins were investigated as to their influence on the nuclear-magnetic relaxation of water protons. The effectiveness increases in the following order: ferricytochrome c (neutral form), horse methemoglobin, horse metmyoglobin, cheironomus methemoglobin, ferricytochrome c (acidic form), hematin. The high effectiveness of the hematin is already decreased by the adsorptive bonding to polyvinylpyrrolidone. The influence on the relaxation of water protons may be divided into a magnetic and a steric component, the latter is thought to be a relative measure for the accessibility of the prosthetic groups in the hemin derivatives. It is shown, that the hemin groups in cytochrome c and cheironomus methemoglobin are situated at the surface more than those of horse methemoglobin or horse metmyoglobin. By the bonding of ligands to the horse methemoglobin the influence of the iron on the relaxation of water protons is attributable not only to the variation of the magnetic moment but also to the variation of the steric arrangement of the prosthetic group to the protein. The methemoglobin fluoride compound shows especially striking behavior. (auth)

24842 STEREOTAXIC INSTRUMENT FOR USE WITH THE BRAGG PEAK OF A PROTON BEAM. R. N. Kjellberg, A. M. Koehler, W. M. Preston, and W. H. Sweet (Massachusetts General Hospital, Boston). Confinia Neurol., 22: 183-9(1962).

A technique is described that permits precise localization of brain targets and their irradiation using the end of the range of a proton beam, the Bragg peak, where ionization effects may be several times greater than elsewhere along the beam path. A stereotactic instrument was devised to guide a pencil-shaped beam of protons from a synchrocyclotron so that the Bragg peak of the beam falls precisely on the predetermined target area. The instrument is designed also for use with conventional probes such as electrodes or a balloon cannula. Protons, hydrogen nuclei stripped of their orbital electrons, are accelerated in a circular path to a speed of 93000 mi/sec or 0.5 the speed of light. Bending magnets divert the protons from the circular path to pass out the portal of the cyclotron. The emerging beam is shaped by 3 brass collimators to a desired configuration, maximizing the sharpness at the edge of the beam. Experimentally a round beam of 7-mm dia. and clinically a beam about 45-mm in its greatest diameter were used. An ionization chamber between the middle and final collimators monitors the integrated dose of radiation. Use of an x-ray tube on the beam axis permits radiologic verification of the beam spot on the brain target. The head holder of the stereotactic instrument has a set of cross hairs on either side that is aligned on the brain target, and the Bragg peak is precisely centered on the intersection of the cross hairs by adjustment of the variable saline absorber. The instrument described is designed for rapid application. It has built-in features to minimize and simplify calculations and to avoid and cross-check against human error. (TCO)

24843 AUTORADIOGRAPHIC STUDY OF CHROMATID DISTRIBUTION OF LABELED DNA IN TWO TYPES OF MAMMALIAN CELLS IN VITRO. D. M. Prescott and M. A. Bender (Oak Ridge National Lab., Tenn.). Exptl. Cell Res., 29: 430-42(Feb. 1963).

The average generation time and the length of the G1, S, and G2 periods were determined for a line of Chinese hamster cells in vitro. On the basis of this information, cells were labeled with H^3-thymidine and the segregation of radioactive DNA in chromatids at metaphase was studied for four consecutive divisions after labeling. In preparation for autoradiography the metaphase chromosomes were freed of cytoplasm. This technique eliminated beta absorption by overlying cytoplasm and permitted an analysis of 80 to 100% of the chromatids of each cell. Autoradiographs of several thousand chromosome sets of each of four divisions after labeling were examined. The labeled DNA segregated according to a semiconservative pattern. The same pattern of semiconservative segregation of DNA was found in human leucocytes in vitro. The frequency of sister chromatid exchanges also was low in this material. (auth)

24844 PERMEABILITY STUDIES OF CHLOROPLASTS FROM NITELLA. P. Saltman, J. G. Forte, and Gertrude M. Forte (Universitet, Copenhagen). Exptl. Cell Res., 29: 504-14(Feb. 1963).

Direct measurements by flame spectrography of the Na^+ and K^+ of the chloroplast, cytoplasmic, and vacuolar fraction of Nitella opaca show that there is no apparent concentration gradient of the ions between the cytoplasm and vacuole. The chloroplasts, however, exclude Na^+ although K^+ is present, and are not in equilibrium with the cytoplasm. Efflux and influx studies have been carried out with

isolated chloroplasts which confirm the existence of a permselective membrane surrounding the chloroplasts which can be disrupted by freeze-thaw or sonication. A descriptive model for ion transport in Nitella is offered. (auth)

24845 PROBLEMS INVOLVED IN THE APPLICATION OF RADIOISOTOPE TECHNIQUES TO ANIMAL EXPERIMENTS. Osamu Matsuoka. Radioisotopes (Tokyo), 12: 75-80(Feb. 1963). (In Japanese)

Problems involved in the application of radioisotope techniques to mammalian biology, especially studies involving the radioassay of animal samples and the related experimental facilities, are reviewed. The γ spectroscopy as applied to the radioassay of Sr^{85}, Fe^{55}, and Fe^{59} is discussed. Ways in which the self-absorption analysis can be simplified are described. Gel filtration and thin-layer chromatography were applied for separating labeled organic compounds. For the radioassay of C^{14} in organic compounds a CO_2 analyzing device was found to be useful, while for similar studies of C^{14} and H^3 in biological materials, liquid scintillation counters were used with good success. The animal handling methods used in the United States are reviewed. (TTT)

24846 DISTRIBUTION OF AERIALLY APPLIED MALATHION S^{35} IN A FOREST ECOSYSTEM. R. H. Giles, Jr., and T. J. Peterle (Ohio Cooperative Wildlife Research Unit, Columbus). IAEA Preprint No. SM-40/29. 42p. (TID-18606)

To be published in IAEA Proceedings of the Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, held in Athens, Greece, Apr. 22-26, 1963.

The distribution of aerially applied S^{35}-malathion (o,o-dimethyl dithiophosphate of diethyl mercaptosuccinate) was studied in forested areas of east-central Ohio during the summer of 1962. A survey on the ecology and fauna of two 20-acre watersheds was conducted. The distribution of the components of the aerial spray within the forest was measured. Samples of surface water, insects, mammals, reptiles, and birds were analyzed to determine the distribution of the insecticide and its metabolites in the ecosystem. (C.H.)

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Refer also to abstracts 24796, 24798, 24799, 24800, 24801, 24802, 25538, and 25562.

24847 (NSEC-93) SURVEY OF IODINE-129 CONCENTRATIONS IN THYROID TISSUES. Progress Report. (Nuclear Science and Engineering Corp., Pittsburgh). May 17, 1963. Contract AT(30-1)-3049. 29p.

Results are reported from studies of I^{129} concentrations in human and other mammalian thyroid tissues. Analytical techniques are described. Data are presented from the analysis of 34 individual whole human thyroid glands and 4 samples of desiccated hog thyroid. The contribution of I^{129} to total thyroid radiation dose is discussed. The data show that current biospheric I^{129} levels are higher by a factor of at least 10^4 to 10^6 than those anticipated as a result of spontaneous fission and cosmic-ray production processes. (C.H.)

24848 (TID-18713) AN ANALYSIS OF CESIUM BODY BURDENS. L. M. Scott (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). [1962]. Contract [W-7405-eng-26]. 14p.

Since July, 1958, cesium data have been collected at the Y-12 Plant In Vivo Radiation Measurement Facility. Approximately 5000 analyses have been made on persons of both sexes ranging in age from 18 to 65 years. A peak in body cesium occurred in June, 1959. A reduction of 44% in body cesium occurred between June, 1959, and resumption of nuclear testing in September, 1961. Relationship between cesium burdens and periods of testing and rate of testing is presented and discussed. Also, relationships between age, body weight, and sex with body cesium are presented and discussed. (auth)

24849 (JPRS-19423) UPTAKE OF RADIOISOTOPES BY SOME AQUATIC INSECTS. A. B. Getsova and G. A. Volkova. Translated from Entomol. Obozrenie, 41: 109-24 (1962). 35p. (OTS-63-21923)

A study was made of the effects of ethylenediaminetetraacetic acid (EDTA) on the uptake of radioisotopes by aquatic insects. Data are reported on the concentration, takeup coefficient, and rate of excretion of radioisotopes at different developmental phases of mosquitoes, caddis flies, and dragon flies. Radioisotopes employed were P^{32}, S^{35}, Ca^{45}, Cr^{51}, Fe^{59}, Co^{60}, Zn^{65}, Sr^{90}, Zr^{95}, Rn^{106}, Cd^{115}, Cs^{137}, Ce^{144}, and Hg^{203}. Results indicate that different species of insects take up the same element to different degrees, and there is variation in the uptake of different elements by the same species. The uptake of radioisotopes varies with the developmental stage of the insect, with larvae taking up more than other stages. The effect of EDTA on uptake was found to be subordinate to general physical and chemical laws governing mineral metabolism. (C.H.)

24850 THE SELECTIVE INJURIOUS RESPONSE OF TESTICULAR AND EPIDIDYMAL BLOOD VESSELS TO CADMIUM AND ITS PREVENTION BY ZINC. Samuel A. Gunn, Thelma Clark Gould, and W. A. D. Anderson (Univ. of Miami, Coral Gables). Am. J. Pathol., 42: 685-702 (June 1963).

In rats the testis and proximal end of the caput epididymis are specifically damaged by cadmium, by virtue of injury to their vascular supply, the internal spermatic artery and pampiniform plexus complex. This injury does not appear when animals are given protective amounts of zinc. Cadmium causes no injury to the distal end of the caput, the corpus and cauda epididymis and the vas deferens; the vascular system nourishing this area, the vasal vessels, also remains uninjured. Blood vessels in other body areas are undamaged. These studies furnish experimental evidence for the premise that endothelium may have a "morphologic organ specificity" with different reactions to various forms of injury. (auth)

24851 I^{131} ACCUMULATION BY THE LACTATING RAT MAMMARY GLAND. Clark E. Grosvenor (Univ. of Tennessee, Memphis). Am. J. Physiol., 204: 856-60 (May 1963).

The mammary glands of lactating rats fed a low-iodine diet accumulated 50% of an injected I^{131} dose or 5 times as much as the thyroid gland and twice as much as excreted by the kidneys in 17 to 24 hr. Rats that accumulated greater amounts of I^{131} in their mammary glands had significantly lesser thyroidal I^{131} uptakes. $KClO_4$ and methimazole significantly reduced accumulation of I^{131} in milk, $KClO_4$ being the more potent. Methimazole acted primarily in reducing the binding of I^{131} to milk protein. The concentration of I^{131} in milk, trichloroacetic acid-precipitable I^{131} in milk and in plasma, and ratio of milk I^{131} to plasma I^{131} were significantly reduced by the addition of iodide to the diet.

The amount of I^{131} in the milk was not correlated with the amount of milk secreted. Exogenous thyroxin inhibited thyroidal I^{131} uptake but did not influence accumulation of I^{131} by the mammary gland. Injection of thyrotrophin restored thyroidal uptake of I^{131} but did not affect accumulation of I^{131} by the mammary gland. (auth)

24852 NUCLEAR PROTEIN SYNTHESIS IN VICIA FABA. Augustine Mattingly (Oak Ridge National Lab., Tenn.). Exptl. Cell Res., 29: 314-26(Jan. 1963).

A technique for the rapid isolation of cytoplasmic-free preparations of Vicia faba nuclei was developed. By using this process and autoradiography, differences in rate and pattern of nuclear incorporation of tritiated lysine, arginine, and tryptophan in the meristematic cells were studied. Lysine is incorporated rapidly into the nucleus, and concentration is particularly evident in the nucleolus and perinucleolar chromatin. Arginine incorporation is somewhat retarded. Long exposures of autoradiographs are necessary to show tryptophan label. Lysine incorporation first becomes evident in the perinucleolar chromatin. The nucleoli become labeled, although the product accumulated is quite mobile and is readily washed out of the nucleoli in the presence of nonradioactive lysine. Chromatin label, on the other hand, may still be found at the end of 48 hr, although the amount of label is decreased. (P.C.H.)

24853 IN VIVO GAMMA SPECTROMETRY FOR INHALATIONS OF NEPTUNIUM-237 – PROTACTINIUM-133, COBALT-60, AND ZIRCONIUM-95 – NIOBIUM-95. R. E. Cofield (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Health Phys., 9: 283-92(Mar. 1963). (In English)

Techniques, calibrations, and efficiencies are reported for the measurement of the amount of three radioisotope systems in the human lungs. The measurement technology for $Np^{237} - Pa^{233}$, Co^{60}, and $Zr^{95} - Nb^{95}$ inhalations is based on in vivo gamma spectrometry with a large (9 in. diameter and 4 in. thick) NaI scintillation detector in an iron room type low background counting chamber. The minimum detectable amounts are 0.00026 μc Np^{237} in equilibrium with Pa^{233}, 0.0006 μc Co^{60}, and 0.001 μc of Zr^{95} or Nb^{95} or $Zr^{95} + Nb^{95}$. These levels of detection are all less than 2 per cent of the amount of the radionuclides which would deliver 0.3 rem/week to the lungs. Data from repetitive measurements on actual inhalation cases are presented for Co^{60} and $Zr^{95} - Nb^{95}$ and a pattern of minimum detectable amount in the lung as a function of gamma energy is developed. (auth)

24854 MEASUREMENT OF THE NATURAL CONTENTS OF RaD (Pb^{210}) AND RaF (Po^{210}) IN HUMAN BONE — ESTIMATES OF WHOLE-BODY BURDENS. R. B. Holtzman (Argonne National Lab., Ill.). Health Phys., 9: 385-400 (Apr. 1963). (In English)

The natural RaD (Pb^{210}) concentration in man was determined from measurement of the RaF (Po^{210}) in bone samples obtained from surgery and autopsy of unexposed individuals, mostly from Illinois. About 63 per cent of the RaD is in the skeleton in apparent equilibrium with RaF and, within a factor of 2, it is uniformly distributed in the skeleton. The average RaD concentration found in 128 bone samples was 0.146 ± 0.020 pC/g ash as compared to an average Ra^{226} concentration of 0.037 ± 0.007 pC/g ash. Little correlation between the two nuclides was observed. The average RaD concentrations in the skeleton were 0.161 pC/g ash in men and 0.119 pC/g ash in women. These concentrations were generally higher in trabecular than in cortical bone, 0.184 and 0.105 pC/g ash, respectively. No particular correlation was found between the residence histories of the donors and the RaD concentrations in their skeletons. Calculations based on some of the metabolic parameters of lead and on the known concentrations of Ra^{226}, Rn^{222}, and RaD in the human biosphere, show food and air to be the major contributors of RaD in the subjects studied. The RaDEF decay chain is shown to contribute a radiation dose to the human skeleton more than double that from Ra^{226} and about equal to that from Ra^{226} and Ra^{228} combined. (auth)

24855 THE BEHAVIOR OF STRONTIUM-85 IN A NORMAL MAN FOLLOWING A SINGLE INGESTION — ABSORPTION AND EXCRETION. M. Fujita, A. Yabe, K. Ueno, M. Oshino, and N. Okuyama (Japan Atomic Energy Research Inst., Tokyo). Health Phys., 9: 407-15(Apr. 1963). (In English)

The rate of fecal and urinary excretion of strontium-85 following a single ingestion, in a normal adult, was measured up to 162 days. Large amounts of unabsorbed strontium were found in the feces during the first 3 days, and only 13.6 per cent of the dose was absorbed. The absorbed portion of the radioactivity showed the turnover of a three-stage process, (1) rapid excretion, (2) an intermediate-rate process, and (3) a chronic retention stage, in accordance with the dose injected intravenously. The urinary-total excretion ratio was $^2/_3$ except for the first 3 days. The variation of plasma concentration of strontium-85 was measured over the first 44 hr after ingestion, and calcium intake and excretion were also measured. It is shown that the urinary excretion of strontium-85 is closely linked with that of calcium and the plasma concentration of strontium-85. (auth)

24856 THE DISTRIBUTION OF DOSE RESULTING FROM A CONSTANT LEVEL OF CONTAMINATION OF THE ENVIRONMENT BY Sr^{90} AND VARIOUS OTHER RADIONUCLIDES. W. S. Snyder and M. J. Cook (Oak Ridge National Lab., Tenn.). Health Phys., 9: 417-23(Apr. 1963). (In English)

The dose rates and annual doses of individuals continuously exposed to radioactive material in the environment will be approximately proportional to the concentration of the radionuclide in the various tissues of these individuals. A stable isotope of the same element should have a similar distribution in these tissues, and thus the form of the distribution of the annual dose or dose rate may be inferred from studies of the distribution of concentrations of stable isotopes in human tissues. Statistical methods given by Brunk and Massey were applied to data for normal isotope distribution in human tissue as reported by Tipton et al., Bryant et al., and Kulp et al. The method by Brunk determines a band such that at each concentration value one may assert with 95 per cent confidence that the true distribution function lies below (above) the upper (lower) boundary of the band. The method by Massey was applied to obtain a 95 per cent confidence band for the entire cumulative distribution curve. In the majority of cases studied one may assert with 95 per cent confidence that not more than 5 per cent of the population groups sampled have concentration values above three times the sample mean, thus providing some quantitative interpretation of the assumption used in the reports of the Federal Radiation Council. (auth)

24857 CESIUM-137 EXCRETION AND RETENTION FOLLOWING SINGLE EXPOSURE. S. E. Hammond (General Atomic Div., General Dynamics Corp., San Diego, Calif.), F. O. Bold, and N. S. MacDonald. Health Phys., 9: 523-8(May 1963). (In English)

Periodic whole-body counting and excretion analyses were performed on a subject who had incurred a 4- to 7-μC internal dose of Cs^{137}. Data are presented correlating urine and fecal excretion with whole-body counts. A single

exponential retention equation was obtained during the period of study, which was from 189 to 582 days after exposure. The retention half time during this period was 80 days. Comparison with the work of other investigators is included. (auth)

24858 THE BEHAVIOR OF STRONTIUM-85 IN A NORMAL MAN FOLLOWING A SINGLE INGESTION—APPLICATION OF THE WHOLE BODY COUNTER FOR THE RETENTION. Susumu Suguri, Satoru Ohtani, Masao Oshino, and Kazuo Yanagishita (Japan Atomic Energy Research Inst., Tokyo). Health Phys., 9: 529-35(May 1963). (In English)

Retention of strontium-85 following a single ingestion in a normal man was measured up to 212 days. It is shown that the retention can be fitted to a three-term exponential function from 2 days after ingestion or to a power function from 30 days after ingestion. The values of f_s^1 and f_w were also determined. The value of f_w for the total body of the subject was 0.13, and f_s^1 and f_w for the bone were 0.20 and 0.025, respectively. The spatial distribution of strontium-85 is also shown. (auth)

24859 THE RATE OF RETURN OF RADIOIODINE UPTAKE BY THE NORMAL THYROID AFTER SUPPRESSION BY PHARMACOLOGICAL DOSES OF STABLE IODIDE. Ann E. Johnson (Univ. of London). Health Phys., 9: 537-8(May 1963). (In English)

It is well known that large doses of stable iodine in any form from Lugol's iodine to "Telepaque" will inhibit thyroid uptake of radioiodine for a variable period, which may be several months in the case of a cholecystogram. It has also been shown that further uptake by the thyroid of radioiodine can be suppressed by pharmacological doses of stable iodide given up to 4 hr after single oral doses of radioiodine. A study was undertaken to determine the duration of the inhibition following a pharmacological dose. Observations after a single oral 200-mg dose of stable iodide show that uptake returns to >50% of the normal value by 3 days, to >80% by 4 days, and to about the normal level by 8 days after the dose. (auth)

24860 A DOUBLE-ISOTOPE DERIVATIVE METHOD FOR PLASMA PROGESTERONE ASSAY. C. A. Woolever (Univ. of Colorado, Denver) and A. Goldfien. Intern. J. Appl. Radiation Isotopes, 14: 163-71(Mar. 1963). (In English)

Studies of the metabolism of progesterone have been hampered by the lack of a specific and sensitive method for the measurement of this steroid in plasma. Application of the double-isotope derivative method offered a solution to this problem. The usual derivative that is used in methods of this type is a tritiated acetate. Since progesterone cannot be acetylated, an alternative was devised by reducing the steroid with sodium borotritide followed by partial reoxidation with manganese dioxide. The resultant product is isolated and purified by paper chromatography prior to counting. The accuracy of the method was demonstrated by assay of solvent samples and analysis of two pools of pregnancy plasma, results of which are given. Another study showed that as little as one milliliter of pregnancy plasma was sufficient to give an accurate result. Authentic progesterone was added to male plasma in amounts of 0.1 μg and 0.2 μg/5 cm^3 of plasma for recovery studies. The measured values of 0.140 ± 0.008 μg/5 ml and 0.232 ± 0.04 μg/5 ml, when compared to values of 0.033 ± 0.009 μg/5 ml, indicated that the latter value represents progesterone endogenous to male plasma. The specificity of the method is shown by a comparison of partition coefficients. Derivatives were made from authentic progesterone-4C^{14} and from a plasma extract. Aliquots of each were partitioned in two systems. The resultant coefficients were 2.86 vs 2.87, and 0.225 vs 0.219. The final derivative was identified as 20-hydroxypregn-4-ene-3-one by R_f values on several chromatogram systems and by crystallization to constant specific activity. (auth)

24861 STUDIES OF COMPLETELY DEUTERIATED PROTEINS. I. THE IMMUNOCHEMISTRY OF THE DEUTERIATED PROTEIN AND ITS HYDROGEN ANALOG. Donald S. Berns (New York State Dept. of Health, Albany and Albany Medical Coll., N. Y.). J. Am. Chem. Soc., 85: 1676-8(June 5, 1963).

Qualitative and quantitative immunochemical evidence, double diffusion studies and precipitin curves are presented to establish the identity of a deuterio protein and its hydrogen analog in primary, secondary, and tertiary protein structure. (auth)

24862 QUANTITATION OF CALCIUM METABOLISM. THEORY. J.-P. Aubert, F. Bronner, and L. J. Richelle (Hospital for Special Surgery and Cornell Univ., New York). J. Clin. Invest., 42: 885-97(June 1963).

A detailed, formal analysis of Ca metabolism is presented that permits measurement of sizes and exchange rates of compartments constituting the Ca pool, as well as the following unidirectional rates: bone formation and resorption, absorption, urinary Ca output, and endogenous fecal Ca loss. The last can also be expressed as a fraction of the rate of formation of digestive juice Ca. Two possible schemes of Ca metabolism are presented and analyzed; these differ in their account of the origin of endogenous fecal Ca. Calculations according to either scheme are detailed. Both general and special methods of analysis of Ca metabolism are presented, their advantages and drawbacks discussed, and their applicability evaluated. (auth)

24863 QUANTITATION OF CALCIUM METABOLISM IN POSTMENOPAUSAL OSTEOPOROSIS AND IN SCOLIOSIS. F. Bronner, L. J. Richelle, P. D. Saville, J. A. Nicholas, and J. R. Cobb (Hospital for Special Surgery and Cornell Univ., New York). J. Clin. Invest., 42: 898-905(June 1963).

By a combination of balance and isotope techniques, the following parameters of Ca metabolism were measured: pool size, rate of loss from pool, urinary excretion, fecal excretion, intake, endogenous fecal Ca, absorption, balance, bone formation, and bone resorption. The subjects were two normal women and five women with postmenopausal osteoporosis, aged 41 to 74 years, and four patients with scoliosis, aged 12 to 22 years. The latter were studied before, shortly after, and many months after immobilization in plaster casts. On the basis of observed relationships, it appeared that the negative Ca balance observed in the older women was due to the low intensity of the various vectors of Ca metabolism, without clearcut distinction between the subjects with and without osteoporosis. Conversely, in the young patients with scoliosis, the negative balance incident to treatment by immobilization was associated with vectors of relatively high intensity whose relationships were altered temporarily. (auth)

24864 Zn^{65} UPTAKE BY BENTHIC MARINE ALGAE. John Gutknecht (Univ. of North Carolina, Chapel Hill and Marine Biological Lab., Woods Hole, Mass.). Limnol. Oceanog., 8: 31-8(Jan. 1963).

The effects of various environmental factors on Zn^{65} uptake and loss were investigated in benthic algae. Increasing the pH promoted Zn^{65} uptake and retarded Zn^{65} loss in Ulva lactuca, Porphyra umbilicalis, and Laminaria

agardi. A similar pH dependency was displayed by killed algae of the same species which in all cases absorbed more Zn^{65} than the live seaweed. The addition of carrier zinc to natural sea-water wash solutions had little effect on the rate of Zn^{65} loss from radioactive algae. Increasing the temperature of the wash resulted in a slight increase in the rate of Zn^{65} loss. Polarographic determinations of the natural zinc content of algae were made. Fucus had the highest zinc concentration, 829 mg/kg dry wt, while Porphyra showed the lowest, 123 mg/kg. Exposure to light stimulated both the uptake and loss of Zn^{65}. Uptake was retarded by two inhibitors, uranyl nitrate and phenylurethane. The biological half-life of Zn^{65} in algae in the light and in the dark was estimated. Fucus showed a much higher retention of Zn^{65} than either Porphyra or Ulva. The effects of photosynthesis-related pH changes on both metabolic and nonmetabolic uptake mechanisms are considered. (auth)

24865 EXCRETION RATE OF Zn^{65} BY LITTORINA IRRORATA IN RELATION TO TEMPERATURE AND BODY SIZE. Jiro Mishima and Eugene P. Odum (Univ. of Georgia, Athens). Limnol. Oceanog., 8: 39-44(Jan. 1963).

Excretion of tracer amounts of Zn^{65} (in terms of biological half-life) was followed in the salt marsh snail, of Littorina irrorata, at 3 constant temperatures in the laboratory and under field conditions in the natural habitat for a period of 39 days following the ingestion of a single dose. The general pattern of elimination could be resolved into 2 exponential phases, an early rapid loss phase for the first 10 days and a much less rapid loss phase thereafter. Biological half-life of the assimilated pool of the second phase varied inversely with body size and directly with air temperature. Individuals in the field excreted the tracer more rapidly than those confined to glass bowls in the laboratory. Analysis of variance showed that both environmental conditions and body size had a highly significant effect on the excretion rate. Furthermore, trends in relation to temperature paralleled the expected rate of O_2 consumption as calculated from data obtained in a previous study. It is tentatively concluded that, after the nonassimilated tracer has been eliminated in the early phase, Zn^{65} becomes sufficiently bound to the biomass so that the whole body rate of excretion reflects rate of activity of the individual. Since body retention of a gamma-emitter can be easily determined in the field by periodic recapture and whole body counts, this technique may provide an index to the long-term rate of metabolism which cannot be measured directly in free-living animals. (auth)

24866 INTERSPECIES DIFFERENCES IN ACCUMULATION OF GAMMA EMITTERS BY MARINE ORGANISMS NEAR THE COLUMBIA RIVER MOUTH. D. G. Watson, J. J. Davis, and W. C. Hanson (General Electric Co., Richland, Wash.). Limnol. Oceanog., 8: 305-9(Apr. 1963). (HW-SA-2857)

Trends of species differences in radionuclide accumulation by marine organisms from near the mouth of the Columbia River are reported and discussed. Marine plankton, sessile algae, mollusks, crustaceans, and fish were collected during April 1959 and 1960, near the river mouth. From 1 to 4 samples of each species were analyzed each year. The concentrations of gamma emitters, expressed in picocuries per gram dry weight, in the various species are tabulated. Plankton and the sessile algae, Fucus furcatus, generally had the highest concentrations of most radioisotopes under consideration. Zn^{65} was most abundant in plankton, sessile algae, and soft parts of mollusks. (P.C.H.)

24867 ON THE INTERACTION BETWEEN BILIRUBIN AND PLASMA ALBUMIN. G. Barac, M. L. Beaumariage, C. Onkelinx, and C. Notay (Université, Liège). Protides Biol. Fluids, Proc. Colloq. 1962, 10: 267-9(Pub. 1963). (In French)

Bilirubin solutions were x irradiated with doses up to 100,000 r in attempts to elucidate the nature of its interaction with serum albumin. It was expected that the reaction of radicals, formed during the radiolysis of water, with the pigment might provide some information on the groups involved in binding albumin. In aerated aqueous solutions free of proteins, sodium bilirubinate and bilirubin were oxidized by the action of x rays to form propentdiopent. This effect becomes marked at doses above 5000 r. In the presence of plasma proteins, the oxidation is considerably reduced. After 100,000 r, 84% of the original bilirubin could be recovered from a solution containing plasma, compared with 8% from an aqueous solution of bilirubin at pH 7.4. In addition to whole plasma, human albumin or its mercurial dimer also exerted a radioprotective effect on bilirubin. It is suggested that protection is afforded at the methane group of bilirubin and that the group is involved in its binding to albumin. (H.H.D.)

24868 TRANSPORT OF NUCLEIC ACIDS AND PROTEINS THROUGH THE CELLULAR MEMBRANES. L. Ledoux and P. Galand (CEN, Mol, Belg.). Protides Biol. Fluids, Proc. Colloq., 1962, 10: 277-9(Pub. 1963). (In French)

Experiments in plants and animals with H^3-labeled macromolecules showed that exogenous ribonucleic acid, deoxyribonucleic acid, and ovalbumin can penetrate cell membranes and become deposited in tissues in macromolecular form. The injected macromolecules are taken up particularly by proliferating tissues, as shown by the rapid uptake of intraperitoneally or intravenously injected DNA-H^3 by the ovaries and vagina of prepupertal mice treated with estradiol. This phenomenon can also be demonstrated in vitro; cultured ascites tumor cells were found to take up RNA, DNA, and proteins. Irradiation of the cells with 800-r doses of x rays inhibited this incorporation of macromolecules, but not that of metabolites from the culture medium. In nonirradiated cells the ingested RNA was selectively taken up by mitochondria, without affecting the respiratory activity of the cells. Injection of RNA-H^3 intraperitoneally in mice results in the rapid labeling of most organs. (H.H.D.)

24869 FECAL AND URINARY EXCRETION OF RADIOISOTOPES. Kenshi Katayama. Radioisotopes (Tokyo), 12: 81-90(Feb. 1963). (In Japanese)

Excretion rates of various isotopes by the rat were studied extensively. The results were compared with data published in the literature. The excretion rates of Sr^{89}, Cs^{137}, Zn^{65}, Hg^{203}, Tl^{204}, Co^{60}, P^{32}, Ca^{45}, and Fe^{55}, administered to the animal orally or by subcutaneous injection, intraperitoneal injection, or intravenous injection, were determined 4, 5, 7, or 8 days after the administration as a percentage of the feces or the urine. (TTT)

24870 RADIOACTIVE IODINE UPTAKE IN HUMAN THYROID UNDER CONDITIONS OF HOT DESERT CLIMATE AND INDUCED HYPOTHERMIA. Z. Lewitus. p.92 of "World Assembly of the Israel Medical Association." Jerusalem, Academy of Medicine, 1962.

The iodine-concentrating capacity of the thyroid gland was measured by the radioactive iodine uptake method. In

the hot desert climate of the Negev (ambient temperature, 40°C in the shade) a decrease was found in the iodine uptake and an increase in the plasma volume. Under hypothermia induced for surgical purposes (body temperature, 30°C) there was an increase in iodine uptake and a decrease in plasma volume. These facts indicate that the observed changes in the iodine uptake may be due to the dilution or concentration of radioactive iodine in an increased or decreased iodine pool under the respective temperature conditions which accompany a change in extracellular volume. (Aerospace Med., 34: 5)

24871 TRANSLOCATION OF P^{32}, N^{15}, AND C^{14} IN PLANTS. Norman Glenn Sansing. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1962. 151p.

The translocation of isotopic tracers was studied with soybean seedlings grown in vermiculite in a plant growth chamber. The P^{32} was applied as a labeled phosphate solution in a droplet to the intact surface of foliage leaves or cotyledons, or in water culture solution to roots. No P^{32} was translocated out of young leaves less than $^1/_4$ expanded. As the leaves matured large amounts of P^{32} were exported. Of the P^{32} translocated out of a treated cotyledon, approximately 60% moved toward the root in 7- and 9-day-old plants. The amount increased from the 10th through the 12th day until a constant value of approximately 88% was reached. P^{32} did not move downward through a section of stem cooled to 0.5°C or through a steamed section. When the cold section or steamed section was above the treated cotyledon, these treatments reduced but did not stop upward movement. The organic products of photosynthesis, labeled with C^{14}, did not move through a steamed section of stem located either above or below the treated leaf. When $N^{15}H_4NO_3$ was applied to the intact cotyledons of soybean, movement of the tracer to the top was reduced 70% by steaming the stem above the treated cotyledon. Steaming had no effect on upward movement when N^{15} was applied through the punctured epidermis of a cotyledon. Steaming the stem was found to reduce movement of N^{15} to the top by as much as 50% when the tracer was applied to the roots. These results support the hypothesis that inorganic ions absorbed by the roots or transferred from the phloem to the xylem move upward in the transpiration stream, while organic compounds are normally limited in their movement to living phloem cells. (Dissertation Abstr.)

24872 THE EFFECTS OF 5-BROMODEOXYURIDINE ON RADIOSENSITIVITY, DNA CONTENT, AND FINE STRUCTURE OF HELA CELLS. William Richard Hendee. Thesis, Austin, Univ. of Texas, 1962. 114p.

HeLa parental cells were cultured from one to seven days in complete growth medium supplemented with the thymidine analogue 5-bromodeoxyuridine (BUDR). Some of the cultures were additionally treated with 5-fluorodeoxyuridine, an inhibitor of thymidine synthesis. Following one to six days of growth in BUDR-containing medium, the cells were exposed to x radiation or ultraviolet light. Cell survival was evaluated by the colony-count method of Puck. Feulgen cytophotometric measurements of DNA content were determined in conjunction with mean cell generation times and growth rates of cell populations. Electron microscopic observations of cell structure were made following x irradiation and/or cultivation in BUDR-containing medium. HeLa cell sensitivity to both x-radiation and ultraviolet light was found to increase following cultivation in BUDR-containing medium. Increased radiosensitivity of HeLa cells was apparent following incubation in BUDR-containing growth medium for a period of time less than that required to complete one division cycle, i.e., about 24 hours. Exposure of HeLa cells to radiosensitizing concentrations of BUDR resulted in decreased cell viability, decreased rate of cell division, increased nuclear size and DNA content, and alteration of cell structure. These multiple manifestations of the biological action of BUDR provided evidence to support the conclusion that cultivation of HeLa cells in the presence of radiosensitizing concentrations of BUDR does not result in true chemical radiosensitization. (Dissertation Abstr.)

Fallout and Ecology

Refer also to abstract 24795.

24873 THE RELATIONSHIP BETWEEN THE CONCENTRATION OF WORLD-WIDE FALL-OUT IN AIR AND IN RAIN. H. H. Ph. Moeken and J. J. H. Alderhout (Health and Safety Section, Eurochemic, Mol, Belg.). Air Water Pollution, 7: 91-3(May 1963). (In English)

A mathematical expression was derived that relates the concentration of fallout in rain and in air. It is useful in assessing grass contamination. (P.C.H.)

24874 THE EFFECT OF WATER TEMPERATURE, AGE, AND SEX ON A FISH ON THE ABSORPTION AND ELIMINATION OF C^{14}. G. V. Fedorova (Leningrad State Univ.). Dokl. Akad. Nauk SSSR, 150: 168-9(Mar. 1, 1963). (In Russian)

Young guppies, and full-grown male and female guppies (Lebistes reticulatus L.) were kept in 6-liter aquariums containing 20 μC/l of C^{14} in the form of $CH_3C^{14}OOH$. The activity was maintained constant at a level of 20 μC per liter. The accumulation coefficient (the ratio of the radioactivity in the fish to the radioactivity in the water) at the end of 30 days was 121.4 for the female fish, only 72.5 for the males, and 261.0 for the young guppies. The level of activity in the male and female fish maintained at a higher temperature of 19 to 21°C was a factor of 2.5 to 3.0 greater than in the fish kept at a temperature of 10 to 16°C. The contamination in the female (680 μC/kg) was again higher than in the male (500 μC/kg). The contaminated fish were placed in clean water to determine the rate of elimination of radioactivity from the fish. The residual activity in the fish at the end of 20 days was 94 to 171 μC/kg, or 13.8 to 34% of the initial activity. The elimination of radioactivity was also faster in females than in males. (TTT)

24875 COMPOSITION AND DEPOSITION IN ITALY OF FALLOUT FROM U.S.S.R. EXPLOSIONS— FALL 1961. Arrigo A. Cigna, Marco M. Ferraris, Franco G. Giorcelli, and Carlo L. Papucci (CEN-CSN, Rome). Health Phys., 9: 319-31(Mar. 1963). (In English)

Samples of fallout collected at various stations throughout Italy since Sept. 1961 were analyzed for gross composition and levels of Sr^{89}, Sr^{90}, and Y^{90}. Air samples were also analyzed. Food chain contamination was evaluated by analysis of samples of milk and sea mollusks. Ten explosions of the U.S.S.R. nuclear test series were dated. (C.H.)

24876 RADIOSTRONTIUM AND CALCIUM. W. Niepmann (Deutschen Arzneimittelgesellschaft Steiner and Co., Werk Beckedorf, Ger.). Med. Klin. (Munich), 58: 381-4 (Mar. 1963). (In German)

The effects of calcium doses on the radiostrontium burden of human and animal organs are reviewed. Twenty-nine experimental works are summarized and discussed. An increased offer of lime in food effectively reduced the oral radiostrontium load and, given over a long period of

time, even lessened the retention of parenteral radiostrontium doses. By immediate calcium infusion after absorption of radiostrontium in human organs, it is quickly eliminated by the kidneys. Significant uses include prophylactic calcium doses for hindering the resorption and increasing the elimination of radiostrontium. Additional oral calcium doses were required in dangerous cases at 1 to 2 g/day. Secondary effects are not expected at these doses. (tr-auth)

24877 IODINE-131 IN THE THYROIDS OF NORTH AMERICAN DEER AND CARIBOU: COMPARISON AFTER NUCLEAR TESTS. W. C. Hanson (General Electric Co., Richland, Wash.), F. W. Whicker, and A. H. Dahl. Science, 140: 801-2(May 17, 1963).

Concentrations of I^{131} in the thyroids of deer from Washington, Colorado, and Maryland, and of caribou from Alaska were measured after the resumption of nuclear weapon tests by the U.S.S.R. on September 1, 1961. Maximum concentrations occurred nearly 2 months after the first nuclear test and then decreased at an effective half time of about 15 days. Thyroids from Washington and Colorado deer showed the highest concentrations, thyroids from Alaskan caribou the lowest. (auth)

Radiation Effects on Living Tissues

Refer also to abstracts 24793, 24803, 24804, 24805, 24808, 24809, 24810, 24811, 24812, 25967, and 25969.

24878 (AD-282000) GLYCIDIC ESTERS AND/OR ORGANIC DISULFIDES, AND RELATED SUBSTANCES, AS SOURCES OF ANTI-RADIATION DRUGS. Annual Progress Report No. 1, for the Period July 1, 1961–June 30, 1962. (Including Interim Research Report No. 11, for the Period April 1, 1962–June 30, 1962). L. Field, R. R. Crenshaw, A. Ferretti, H. Haerle, W. B. Lacefield, and T. F. Parsons (Vanderbilt Univ., Nashville). July 3, 1962. Contract DA-49-193-MD-2030. 20p.

Seven compounds were studied for anti-radiation properties. With one exception, they are all thiolsulfonates or disulfides. The oxidation of symmetrical and unsymmetrical disulfides to thiolsulfonates was also studied. The synthesis of o-2-aminoethyldithiobenzoic acid lactam is described. Studies on the rates of reaction of thiolsulfonates with thiols to give disulfides were initiated; interesting results in attempted oxidation of a hindered disulfide to a desired thiosulfonate indicated marked resistance to oxidation. Other means for synthesizing thiolsulfonates and disulfides were developed or extended, for example by irradiation of a sulfonyl iodide in the presence of a disulfide and by attack of a sulfinate anion upon a thiolsulfonate. (P.C.H.)

24879 (AFSWC-TDR-62-96) EFFECTS OF COBALT-60 IRRADIATION TO THE REGION OF THE BRAIN OF THE BURRO. CLINICAL SIGNS AND SYMPTOMS. Ronald E. Engel, Vaughn C. Moore, and Francis A. Spurrell (Air Force Special Weapons Center, Kirtland AFB, N. Mex.). Jan. 1963. 19p.

Seven burros received 600 r and four burros 200 r of gamma rays from a bilateral cobalt-60 source to the region of the brain. Each burro had a paired control that was sham-irradiated. The principal target was the brain. Six out of seven burros receiving 600 r died in the terminal phase of the hyperacute radiation syndrome. The animals that received 200 r showed a few transient abnormal neurological signs. Irradiated burros exhibited abnormal neurological signs at relatively low doses of radiation to the region of the brain when compared to other irradiated mammalian species. (auth)

24880 (CEA-2282) DETERMINATION DES IRRADIATIONS PAR CONTAMINATION INTERNE DE L'ORGANISME. (Determination of the Exposure Due to Internal Contamination of Organism). H. Joffre (France, Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 27p.

Methods are described for measuring the radiation dose to mammals due to internally deposited radioisotopes acquired through inhalation or ingested. Data are reviewed on maximum permissible radiation doses for internal contamination. (C.H.)

24881 (COO-227) RESEARCH IN RADIOBIOLOGY. Annual Report of Work in Progress on the Chronic Toxicity Program. Thomas F. Dougherty (Utah. Univ., Salt Lake City. Coll. of Medicine). Mar. 31, 1963. Contract AT (11-1)-119. 240p.

Separate abstracts were prepared on 10 sections of this report. (C.H.)

24882 (COO-227(p.57-79)) SELECTIVE DEPOSITION OF RADIUM IN NORMAL AND NEOPLASTIC MELANOCYTES. G. N. Taylor, B. J. Stover, W. S. S. Jee, and C. W. Mays (Utah. Univ., Salt Lake City. Coll. of Medicine).

Selective deposition of Ra^{226} in the pigmented melanocytes of a canine malignant melanoma followed the injection of 25.1 μc Ra^{226}/kg. By approximately 35 days after injection, the tumor had decreased to less than one third its pre-injection size. Regression of metastases that were superficially palpable occurred concurrently. Alpha track counting indicated that the concentration of Ra^{226} in melanocytes and/or melanophores from the melanoma ranged from 40 to 630 μc Ra^{226}/kg. These preliminary data suggest the possible therapeutic use of radium in the treatment of malignant melanomas. (auth)

24883 (COO-227(p.80-1)) HEMATOLOGICAL FINDINGS FOLLOWING INJECTION OF Ra^{226} INTO A DOG WITH MALIGNANT MELANOMA. Jean H. Dougherty (Utah. Univ., Salt Lake City. Coll. of Medicine).

The hematological changes following injection of an acutely lethal dose of 25 μc Ra^{226}/kg into a beagle with malignant melanoma are reported. There was a marked leukopenia and thrombocytopenia and a mild anemia eleven days following injection. At the time of the death, 49 days post injection, there was a beginning recovery of the leukocytes and red cells. (auth)

24884 (COO-227(p.83-9)) HIGH RADIUM CONCENTRATION IN MELANOMA TISSUE. Charles W. Mays and Glenn N. Taylor (Utah. Univ., Salt Lake City. Coll. of Medicine).

Radium concentrations in samples of highly pigmented melanoma tissue were roughly equal to those in bone, but 20 to 500 times higher than in other soft tissues of a beagle which died 49 days after the therapeutic injection of 25 μc Ra^{226}/kg. (auth)

24885 (COO-227(p.90-106)) RELATION OF MICROSCOPIC METABOLISM OF RADIUM TO RADIATION DAMAGE. Kendrick A. Sears, Webster S. S. Jee, Robert K. Haslam, and Charles W. Mays (Utah. Univ., Salt Lake City. Coll. of Medicine).

The specific activity in microscopic areas of four bones from 15 adult beagle dogs injected intravenously with a single dose of 10 μc Ra^{226}/kg body weight was determined. These dogs were sacrificed from 12 to 1380 days after

injection. The ratio of hottest hotspot to uniform skeletal label averaged 21 in the lumbar vertebrae, 13 in tibial shaft, 15 in mandible, 13 in femoral shaft, 14 in femoral epiphysis, and 14 in femoral metaphysis. There appears to be a greater diffuse uptake by existing bone in the vertebrae, mandibles, and distal femurs than in the femoral and tibial shafts. The fractional rates of loss are different in different bones. Loss is greater from the vertebrae and mandibles than from the femurs and tibiae. Essentially the same fractional rate of loss is seen from a hotspot and its adjacent diffuse area. (auth)

24886 (COO-227(p.107-19)) QUANTITATIVE MICROSCOPIC DISTRIBUTION OF RADIUM^{226} IN DENTAL TISSUES AND MANDIBLES OF ADULT BEAGLES. [PART] I. R. K. Haslam, K. A. Sears, and W. S. S. Jee (Utah. Univ., Salt Lake City. Coll. of Medicine).

Adult beagles were given a single intravenous injection of 10, 3, or 1 μc Ra^{226} citrate/kg body weight. Radium deposited in the cementum, alveolar bone, mandibular bone, and dentin. Deposition in the dentin was in the form of hotspots in the rapidly mineralizing dentin and in a diffuse deposition in the dentin adjacent to this hot layer. Hotspots in the dentin were about as active as those hotspots found in the mandible and were 18 times as active as the average diffuse bone of the mandible. Diffuse deposition in the dentin showed a decrease in activity with increasing distances from the hotspots. Both hot and diffuse activity in dentin slowly decreased with increasing time after injection. (auth)

24887 (COO-227(p.120-50)) THE INFLUENCE OF REDUCED LOCAL VASCULARITY ON THE RATE OF INTERNAL RECONSTRUCTION IN ADULT LONG BONE CORTEX. W. S. S. Jee, M. Lowe, Renate Tegge, Renon Mical, and K. Sears (Utah. Univ., Salt Lake City. Coll. of Medicine).

Plutonium was found to deposit in pre-injection and post-injection osteons in divergent patterns, thus allowing for an accurate method to assess the amount of bone formed subsequent to the introduction of the radionuclide. This unique technique was used to determine the rate of remodeling and the distribution pattern of remodeled osteons in the proximal tibial compacta of dogs injected with 2.7, 0.9, or 0.3 μc Pu^{239}/kg. Accordingly, these determinations were found to be excellent endpoints for irradiation damage. A reduction in patent vascular channels and viable osteocytes was found in the treated dogs accompanied by a tendency to enhance the rate of internal reconstruction. These events appeared to be dose dependent. Other indices of rate of remodeling, such as areas occupied by recently formed osteons, helped to estimate the remodeling rate of the proximal tibial compacta of controls to be 2% per year. The significance of the role of vascularity, internal irradiation, and necrosis of osteocytes as causal factors of remodeling as well as changes in distribution pattern of remodeling sites are discussed. (auth)

24888 (COO-227(p.151-69)) THE EFFECT OF X-IRRADIATION ON THE CONJUGATION OF STEROIDS BY MOUSE LIVER AND KIDNEY. Walter Stevens and David L. Berliner (Utah. Univ., Salt Lake City. Coll. of Medicine.)

Livers and kidneys from male CBA mice were assayed for their ability to conjugate compound X (pregnane-3α-ol-11,20-dione-4-C^{14}) and corticosterone (4-pregnen-11β, 21-diol-3,20-dione-1,2-H^3) at various time intervals following 500 r of whole-body x irradiation. In vitro conjugation of compound X as a glucuronide by the kidney was significantly decreased on the 1st, 5th, 13th, and 21st days following irradiation. Irradiation significantly decreased the in vitro conjugation of compound X by the liver on the 5th and 21st days post-irradiation. The decrease in conjugation on the 1st day post-irradiation was non-significant and the decrease on the 13th day post-irradiation has a P value range of ($0.05 < P < 0.1$). This decrease in conjugation was reflected in the amount of steroid released by β-glucuronidase hydrolysis. The in vitro conjugation of corticosterone by the liver was significantly decreased only on the 21st post-irradiation day following 500 r. There was no significant decrease in conjugation of corticosterone by the liver on the 1st, 5th, or 13th days post-irradiation. The amount of glucuronide formed from corticosterone by the liver on the 5th, 13th, and 21st day post-irradiation was significantly decreased. (auth)

24889 (COO-227(p.170-84)) THE EFFECTS OF IONIZING RADIATION ON ENDOCRINE CELLS. I. METHODS OF STUDY AND BIOTRANSFORMATION OF 5-PREGNENOLONE AND PROGESTERONE INTO ANDROGENS BY MOUSE TESTES. LeGrande C. Ellis and David L. Berliner (Utah. Univ., Salt Lake City. Coll. of Medicine.)

Methods are presented for the isolation, purification, and characterization of the intermediates produced when 5-pregnenolone-7α-H^3 and progesterone-4-C^{14} were incubated with mouse testes. With these techniques it was shown that 17 α-hydroxyprogesterone and androstenedione are important intermediates in the formation of testosterone from these two substrates. The sequence of biotransformations established was the conversion of 5-pregnenolone → progesterone → 17α-hydroxyprogesterone → androstenedione → testosterone. Levels of biotransformation of steroids by mouse testes were established as a baseline for subsequent studies on the effects of radiation on this phenomenon. (auth)

24890 (COO-227(p.185-203)) SOFT TISSUE RETENTION OF Ra^{226} IN THE BEAGLE. David R. Atherton, Betsy J. Stover, and Charles W. Mays (Utah. Univ., Salt Lake City. Coll. of Medicine).

Results of measurements of radium retained in the soft tissues of beagles which were given a single intravenous injection of that radionuclide are tabulated. The relative contribution of soft tissues to total-body retention decreases with increasing time after injection. After two months, soft tissue retention is less than 3% of the whole-body content and about 40% of the amount in soft tissue is found in the liver, kidneys, and spleen. (auth)

24891 (COO-227(p.204-14)) FAILURE TO DETECT A 1.75-Mev GAMMA-RAY FOLLOWING THE DISINTEGRATION OF Y^{90}. R. D. Lloyd and C. W. Mays (Utah. Univ., Salt Lake City. Coll. of Medicine).

The possible existence of a 1.75 Mev γ-ray following the disintegration of Y^{90} is implied in the Table of Isotopes, Rev. Mod. Phys., 30: 585(1958). We have established that if such a γ-ray really exists, its abundance is less than 3×10^{-7} γ-rays per Y^{90} disintegration. Therefore, it occurs too infrequently to use in total-body counting of animals containing Sr^{90} + Y^{90}. (auth)

24892 (NYO-10451) ANNUAL REPORT ON RESEARCH PROJECT. (Columbia Univ., New York. Radiological Research Lab.). Jan. 1, 1963. Contract AT(30-1)-2740. 198p.

Developments in dosimetry include the design of a tissue-equivalent conducting plastic ionization chamber for use in measurements of total absorbed dose from monoenergetic neutrons in the mouse eye in cataract studies, design of a

gas multiplication chamber using tissue-equivalent gas in a tissue-equivalent plastic cylinder, the dosimetry of tissue cultures exposed to an α source using layers of mylar between the ionization chamber and irradiation column, the dosimetry of 3 Bev protons from a pulsed beam using photographic film clamped to a 3-in.-diameter cylindrical phantom having an axis roughly parallel to that of the beam, measurements of probability distributions of local energy density in microscopic tissue spheres using different sizes and absorbed doses, and the construction of small tissue-equivalent proportional counters to simulate a chromosome. A computer was used in attempts to correlate dose-effect curves for unicellular systems with energy density distributions. Modifications are reported in the design of dosimeters for use in mixed radiation fields, and the design of a low-voltage x-ray-generator for delivery of high dose rates in the photon energy region between 1 and 10 Kev. Investigations on the relative biological effectiveness of neutrons as a function of neutron energy were continued and techniques were developed for use in studies of radiation effects on cells in tissue culture. Data are included from studies on factors affecting the radiosensitivity of bacteria with emphasis on the response of E. coli to ultraviolet radiation; spontaneous mutation rate and aging in Drosophila melanogaster, and radiation effects on developing mammalian embryos and fetuses. (C.H.)

24893 (TID-18672) THE USE OF RADIATION TREATMENT METHODS TO STUDY RICE GENETICS AND IMPROVE VARIETIES USED IN SOUTHEAST ASIA. Final Report. T. Y. Ouang (Taiwan. Provincial Chung-hsing Univ., Taichung, China). Feb. 1963. Contract [AT(30-1)-2640]. 56p.

Seeds from 51 varieties of wild and cultivated rice collected in Southeast Asia and Africa were exposed to x radiation, γ radiation, or chemical treatment. Plants from these seeds, and crosses of the plants, were analyzed through 6 generations for characteristics indicating improved varieties, resistance to diseases, and resistance to drought. Results were analyzed statistically. Data are tabulated. (C.H.)

24894 (TID-18673) INVESTIGATIONS OF MUTABILITY OF POLYGENES AND ON UTILIZATION OF INDUCED GENETIC VARIABILITY. Progress Report. R. E. Scossiroli (Pavia, Italy. Universita. Istituto di Genetica). Mar. 31, 1963. Work Performed under Contract IAEA 61/US. 27p.

Data are summarized from studies on the effectiveness of x irradiation of seeds in producing mutations of maize, wheat, and tobacco with characteristics desirable for crop improvement. Plants from the second through the fourth generation were analyzed by the use of direct estimates of environmental components of variation and of more accurate estimates of genetic components. A list of publications resulting from the study is included. (C.H.)

24895 (TID-18721) AN INVESTIGATION ON THE MECHANISMS AND REGULATIONS OF NUCLEIC ACID AND PROTEIN SYNTHESIS, AND THEIR POSSIBLE RELATIONSHIP TO RADIATION DAMAGE. Progress Report, September 1, 1962 to August 31, 1963. Paul C. Zamecnik and Joseph W. Gardella (Massachusetts. General Hospital. John Collins Warren Labs., Boston). Contract AT(30-1)-2643. 10p.

Progress is reported in tracer studies on the mechanism of protein synthesis, the metabolism of ribonucleic acid in various biological systems, desoxyribonucleic acid synthesis in partially synchronized mouse fibroblasts, and nucleic acid synthesis during hepatic regeneration. A list is included of publications during the period covered by this report. (C.H.)

24896 (TID-18723) DETERMINATION OF THE RBE OF 14-Mev NEUTRONS USING 14 DAY OLD GRASSHOPPER EMBRYOS (CHORTOPHAGA VIRIDIFASCIATA AND ENCOPTOLOPHUS SORDIDUS) (thesis). Wayne R. Hansen (Kansas. Univ., Lawrence. Graduate School). May 1963. 65p.

The LD_{50} determined for 14-day, 15-day, and 17-day Chortophaga embryos irradiated with 200 Kvp x rays was respectively 450 rads, 400 rads, and 580 rads. The mean lethal dose for 14-day, 15-day, and 17-day Encoptolophus embryos irradiated with 200 Kvp x rays was respectively 510 rads, 580 rads, and 630 rads. The LD_{50} for 14-day Chortophaga embryos irradiated with 14 Mev neutrons was 370 rads. The RBE of 14 Mev neutrons was determined to be 1.22. The mean lethal dose determined for any group of Chortophaga and Encoptolophus embryos was dependent on the stage of embryo development. The hatching time of the eggs irradiated with x rays was delayed. The amount of delay was increased as the dose of x rays was increased. The period of hatching was also spread over a greater length of time with increased doses of x rays. (auth)

24897 (TID-18792) PROGRESS REPORT [ON BIOLOGICAL RESEARCH], OCTOBER 1, 1962–JUNE 1, 1963. Theodosius Dobzhansky (Rockefeller Inst. for Medical Research, New York). Contract AT(30-1)-3096. 11p.

Results are reported from studies on the nature and magnitude of the genetic load in natural populations of certain species of Drosophila. Results are included from experiments on the viability effects of genetic variants in natural populations in homozygous and heterozygous condition, a study of chromosomal variants in a natural population of Drosophila pseudoobscura, and genetic loads in irradiated populations of Drosophila. (C.H.)

24898 (TID-18794) MUTATION RESEARCH WITH GAMMA RADIATION AT A SPECIFIC LOCUS IN A HIGHER PLANT. A. T. Wallace (Florida. Agricultural Experiment Station, Gainesville). [1962]. Contract AT(40-1)-2562. 39p.

The induced mutation rate for oats exposed to γ radiation was determined. Emphasis was placed on identification of the locus controlling the reaction to the fungus Helminthosporium victoriae. The effects of pre- and post-irradiation treatments on induced mutation rate was also studied. (C.H.)

24899 (USNRDL-TR-636) DIFFERENTIAL RADIOSENSITIVITY OF FIRST- AND SECOND-SET RESPONSES TO ALLOGENEIC AND XENOGENEIC SKIN GRAFTS IN SUBLETHALLY IRRADIATED MICE. M. L. Tyan and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Apr. 15, 1963. 17p. (AD-404808)

Data are presented demonstrating the differential radiosensitivity of the first and second-set responses of sublethally irradiated (670 rad) mice previously sensitized with allogeneic (H-2 difference), xenogeneic (rat), or both allogeneic and xenogeneic skin grafts. The second-set response is more radioresistant than is the first-set response; the second-set response to a xenogeneic graft remains intact during and following recovery from the effects of sublethal irradiation; while intact for a brief period following irradiation, the second-set response to an allogeneic skin graft was abrogated by sublethal irradiation (670 rad); concurrent pre-sensitization with allogeneic and xenogeneic skin grafts prevented the abrogation of the second-set response to the allogeneic graft by sublethal irradiation; the first-set response to an allogeneic graft recovered from the effects of sublethal irradiation prior to the recovery of the first-set response to a xenogeneic graft. (auth)

24900 (JPRS-19355) THE EFFECT OF SODIUM GALLATE ON THE NUCLEIC ACID CONTENT IN THE ORGANS OF HEALTHY AND IRRADIATED RATS. V. A. Baraboi (Baraboy) and S. P. Matsui (Matsuy). Translated from Ukr. Biokhim. Zh., 35: 84-90(1963). 8p. (OTS-63-21895)

The administration of sodium gallate to healthy rats produced two-phase quantitative changes in nucleic acid levels: first there was drop in the NA level and then a rise back to the normal level, which continued until this level was exceeded. RNA changes were much more evident than DNA. The restoration of the normal NA level in organs after the administration of sodium gallate occurred more rapidly than when propyl gallate was used, and was characterized by the especially significant rise in the NA level. Prophylactic doses of sodium gallate prior to irradiation on the third day following treatment produced greater drops in the NA level than the radiation in the spleen and testicles of the test specimens. The effect of sodium gallate, which intensifies nucleic exchange, is manifest by the 7 to 13th day in the relatively rapid restoration of the NA level; this represents an important factor in the protective antiradiation action of this agent. The restoration of the NA level in the organisms of rats receiving sodium gallate prior to irradiation occurred more rapidly than with the administration of propyl gallate as the protective agent. (auth)

24901 DOSE RATE, CYANIDE, AND SOME OTHER FACTORS INFLUENCING REPAIR OF MUTATIONAL RADIATION DAMAGE IN DROSOPHILA. F. H. Sobels (Rijksuniversiteit, Leiden). Abhandl. Deut. Akad. Wiss. Berlin, Kl. Med., 115-30(1962).

In irradiated Drosophila spermatids and spermatocytes, repair processes were shown to occur in flies by treatment with cyanide. In the germ cell stages showing peak sensitivity to radiation, post-treatment with cyanide resulted in a significant increase of the mutation frequency, if x irradiation was given at a high dose rate of 2200 r/min. Post-treatment following radiation at lower dose rates of 600 r/min or 150 r/min, however, did not notably change the frequency of mutation. Evidence was obtained that the increase in lethal frequency due to cyanide involves gene mutations and possibly small deletions. Cyanide may also inhibit a system responsible for repair of part of the premutational radiation damage, and it was shown that cyanide can produce both enhancement and lowering of the mutation frequency induced by high-intensity radiation in spermatids. Pre-treatment experiments under conditions (N_2 or O_2), where cyanide is ineffective, if preceding low-intensity radiation, suggest that there is a specific dose rate dependence in the presence of cyanide. It was assumed that in the presence of cyanide high-intensity radiation, apart from direct damage to the chromosomes, affects a second susceptible system, which may be associated with repair processes. Other observations on modification of radioinduced frequencies after dose fractionation, post-treatment with nitrogen, and pretreatment with both chloramphenicol and ribonuclease are reported. (TCO)

24902 RADIATION-INDUCED CHROMOSOME ABERRATIONS IN HUMAN FETAL CELLS GROWN IN VITRO. J. A. Boeok (Uppsala Univ.). Acta Genet. Med. Gemellol. (Rome), 11: 356-89(Oct. 1962). (TID-18016). (In English)

Diploid human cells (from fetal lung and brain) grown in vitro were irradiated with Co^{60} γ rays. The effect of radiation was measured by recording postmetaphase chromosomal aberrations in cell cultures fixed and stained 24 and 48 hr after acute irradiation. Spontaneous aberration frequencies were determined in matched control cultures. The frequency of spontaneous aberrations appeared to vary with respect to: differences between the individual fetuses from whom the biopsied cells were taken; tissue of origin whether within or between individuals; and the sex of the cultured cells. Estimates of the overall averages of spontaneous aberrations were 0.7% for the cell cultures derived from fetal lung and 2.5% for those from fetal brain. In the irradiated cell cultures, which received doses varying from 9 to 136 rad, the number of aberrant postmetaphase figures per 100 cells/rad varied from 0.10 to 0.15 for cultures derived from lung and from 0.19 to 0.37 for cultures from brain, all at 24 hr. At 48 hr after irradiation the frequencies were somewhat lower but the same trends remained the same. Cell cultures derived from brain appear to have a higher radiosensitivity than those derived from lung. Furthermore, a sexual dimorphism was evident because, in all series of cultures, those composed of XY cells had a higher aberration frequency as compared to those with XX cells. (TCO)

24903 RADIATION-SENSITIZING EFFECT OF p-CHLOROMERCURIBENZOATE. S. Damjanovich, M. Szabolcs, J. Csongor, I. Szatai, and A. Dolhay (Medical Univ., Debrecen, Hungary). Acta Physiol. Acad. Sci. Hung., 22: 195-9(1962). (In English)

p-Chloromercuribenzoate (PCMB), a specific sulfhydryl inhibitor, was tested in vitro and in vivo for ability to enhance the injurious effects of x rays on biologic systems. The physical properties of human serum albumin (HSA) were tested before and after irradiation in solution at pH 5.4 containing 10 μg/ml PCMB. Examination of the uv absorption spectrum between 240 and 320 mμ showed that HSA underwent more marked changes in the presence than absence of PCMB. Electrophoretic analysis showed appreciable differences between the irradiated and control HSA, but the differences were not affected by PCMB to any noticeable extent. In in vivo experiments rats received 900 r whole-body irradiation, and 1 hr prior to irradiation were injected intraperitoneally with 10 μg/g body wt PCMB. Other rats were treated with 1400 mg/kg cysteine-HCl 1 hr before irradiation. Cysteine increased survival time to 7 to 9 days compared with a control time of 4 to 5 days but PCMB did not affect survival time; unirradiated rats injected with PCMB also died in 4 to 5 days. In other rats irradiated with 500 r, injection of 5 μg/g PCMB lowered the average survival time to 3 to 4 days from 10 to 12 days (this time was 6 days after PCMB injection alone). Increasing doses of PCMB did not further shorten survival time. It is suggested that in the case of HSA, radiosensitization by PCMB may involve blocking sulfhydryl groups so that they cannot be oxidized by free radicals formed by radiolysis of water, or PCMB may interact with sulfhydryl groups and thereby alter the secondary structure of HSA. (H.H.D.)

24904 EFFECTS OF X IRRADIATION ON THE MUCOPOLYSACCHARIDES IN THE AORTIC WALL. H. B. Lamberts (Universiteit, Groningen, Netherlands). Acta Physiol. Pharmacol. Neerl., 11: 283(1962). (In English)

The effects of irradiation on aortic mucopolysaccharides were investigated in vitro and in vivo. Injection pressure in media and intima drops instantaneously during in vitro irradiation of aorta with 1000 r, indicating an increased water permeability. Diffusion of dyes into the intimal layer occurred at an increased rate in x irradiated segments of excised aorta (human, cow, pig, dog). Injection of dye solutions in rats after whole-body irradiation (3000 r), followed by spectrophotometric estimation of dye

content in the intimal membrane, demonstrated an increased accumulation of dye (trypan blue, Evans blue, hematoporphyrin) in comparison with measurements on aortas of nonirradiated control animals. In experiments with rabbits fed on a high cholesterol diet, irradiation with 100 r weekly for 10 weeks resulted in a higher incidence of atheromatous lesions, compared with nonirradiated animals fed the same diet. The presence of $Na_2S_2O_3$ provided an effective protection against the drop of injection pressure and the increased diffusion rate of dyes after irradiation. It is suggested that the described vascular radiation effects may contribute to the shortening of life-span after sublethal and chronic irradiation and that $Na_2S_2O_3$ may have protective value against these effects. The results suggest that mucopolysaccharide depolymerization is caused by x irradiation, which is reflected by increased permeability of the aorta. (TCO)

24905 RESIDUAL THOROTRAST IN THE PARANASAL SINUSES. A STUDY OF ITS ROENTGEN APPEARANCE AND IMPLICATIONS. Frieda Feldman, William B. Seaman, and Josephine S. Wells (Columbia Univ., New York). Am. J. Roentgenol., Radium Therapy Nucl. Med., 89: 1147-54(June 1963).

Three additional cases of thorotrast retention within a paranasal sinus are added to the 7 previously reported in the literature. Carcinoma of the antrum developed in 2 of these cases approximately 10 years and 15 years after instillation, while the third case exhibited benign polypoid changes 13 years after instillation. Its recognition within a sinus cavity is important, not merely from the standpoint of the removal of a foreign body, but from the proclivity of this substance to produce necrosis and malignant change in tissue with which it remains in contact. (auth)

24906 ACTION OF X IRRADIATION ON THE NICTITATING MEMBRANE OF THE CAT. A. Dresse, M. L. Beaumariage, and Z. M. Bacq (Université, Liège). Arch. Intern. Physiol. Biochim., 71: 101-4(Jan. 1963). (In French)

Irradiation of the center of the eye of cats caused an increase in the contraction of the membrane produced by intravenous injection of adrenaline. The response appeared 10 to 30 min after exposure of the eye to 10000 r and became accentuated with time. A 4-fold higher radiation dose caused a potentiation of 300% in the effect of adrenaline. The effects of electrical stimulation of the nerve were not augmented; in fact, the contraction amplitude was lower after 40000 r irradiation. Surgical or pharmacologic denervation of the nictitating membrane almost completely suppressed the radioinduced potentiation to catechol amines. Radiation appears to act in a manner similar to that of some drugs, such as reserpine and guanethidine, which reduce the reserves of noradrenaline at postganglionic endings, thus diminishing the response to nervous stimuli while augmenting the contractions induced by injected adrenaline. X rays, in a sense, have a denervating effect on the membrane. Membranes in which the reserves of noradrenaline have been depleted by section of the postganglionic fibers or by guanethidine fail to react in this way. However, the parallelism is not complete, since with x rays the phenomenon seems to be irreversible. (TCO)

24907 THE RADIOSENSITIVITY OF CULTURE OF ESCHERICHIA FREUNDII AS A FUNCTION OF THE ACCUMULATION OF INTRA- AND EXTRACELLULAR CITRATE PRODUCED BY ADDITION OF FLUOROACETATE TO THE CULTURE MEDIUM. C. Liebecq and P. M Osterrieth (Université, Liège). Arch. Intern. Physiol. Biochim., 71: 112-13(Jan. 1963). (In French)

In the presence of 10^{-4}M sodium fluoroacetate, cultures of E. freundii (strain EF 5) in a 0.5% glucose medium with an initial pH of 4.8 accumulate relatively large amounts of citric acid. Bacteria grown under these conditions are less radiosensitive than control cultures grown in the absence of fluoroacetate. However, in subsequent experiments it was possible to produce cultures that produced large quantities of citric acid without showing radioresistance. Thus there does not seem to be a correlation between citric acid concentration of the medium and radiosensitivity of the bacteria, nor can any radioprotective action be attributed to citric acid. At the pH of the medium it would have only low complexing activity. A slight but significant diminution of radiosensitivity was observed in cultures grown in 0.1% glucose medium at pH 6.8 in the presence of fluoroacetate. In this case, citric acid accumulates intracellularly only; its concentration reaches ~18 μg/mg nitrogen as compared with 6 μg/mg in control cultures. It is suggested that it may be the internal accumulation of citric acid that confers protection on the cells. The results may be analogous to earlier studies in mice, in which it was noted that injection of fluoroacetate (causing a considerable accumulation of citric acid in the tissues) enhanced radioresistance. (H.H.D.)

24908 INFLUENCE OF ARTIFICIAL HIBERNATION ON THE PHENOMENON OF DIFFUSION IN THE SKIN EXPOSED TO IONIZING RADIATION. Paolo Moroni (Università, Bologna). Arch. Ital. Dermatol. Venereol. Sessuol., 30: 484-92(Nov.-Dec. 1960).

Attempts were made to alter the reaction of depolymerization of mucopolysaccharides in the skin following irradiation by submitting guinea pigs to hypothermia. The animals were injected with 5 mg trifluoropromazine intraperitoneally, which resulted in a 2.5° drop in body temperature 1 hr later. Skin was locally irradiated with 1000-r doses of 50-kv x rays 1 hr after intracutaneous injection of a 0.1% solution of trypan blue. Irradiation of the skin of untreated animals (nonhypothermic) resulted in increased diffusion of the dye in both control and irradiated areas of skin, but the effect was more pronounced in irradiated regions. One hr after irradiation the diffusion area was double that found in unirradiated animals and 24 hr later it was 10 and 30 times greater, respectively, in control and irradiated regions of skin. Hypothermia markedly diminished the diffusion area in irradiated but not in unirradiated skin; the area was only 4 times greater than normal in contrast to the 30-fold increase in nonhypothermic animals. Also, diffusion reached a maximum at about 6 hr postirradiation in hypothermic animals in contrast to the area controls, which continued to expand for 24 to 36 hr. The results indicate that in the hibernating state the ground substance mucopolysaccharides are less vulnerable to the depolymerizing action of ionizing radiation. (TCO)

24909 STUDIES ON THE RADIATION RESISTANCE OF SOME PSYCHROPHILIC BACTERIA AND YEASTS OF MARINE FISHES. W. Schmidt-Lorenz and J. Farkas (Bundesforschungsanstalt fur Lebensmittelfrischhaltung, Karlsruhe, Ger.). Arch. Mikrobiol., 39: 1-12(1961).

Studies were conducted on 21 bacterial and 5 yeast species isolated from codfish; the cultures were irradiated with soft (60-kv) x rays to evaluate their radioresistance. Among the most resistant were yeast and Micrococcus species, while Pseudomonas and Flavobacterium species were the most sensitive of those tested. LD_{99} values, expressed as kr, for various species of the genuses were: Micrococcus 23-75, Corynebacterium 10-19, Achromobacter 9-18, Aeromonas 12-14, Flavobacterium 5-6, Pseudomonas 3-6, Torulopsis candida 64, and Torulopsis famata

42. Other yeasts (Rhodotorula mucilaginosa, Debaryomyces subglobosus, D. kloeckeri) showed values similar to the latter two. The influence of the age of the cultures and temperature was also investigated. In contrast to findings in Escherichia coli, which showed relatively higher radioresistance at the end of the logarithmic growth phase, the psychrophilic bacteria studied showed no significant variation of resistance in relation to growth phase. Moreover, in contrast to E. coli, which showed a 4-fold higher sensitivity at 10°C compared with the range 20 to 44°, the psychrophilic species showed almost uniform sensitivity over the range 0 to 30°. Most of the species showed optimal growth at 20 to 25°, but growth occurred, after a delay, at temperatures as low as 0°. (H.H.D.)

24910 MORPHOLOGY AND FUNCTION IN THE EXPERIMENTALLY X-IRRADIATED KIDNEY. Leonardo Bianchi (Kantonsspitals, St. Gallen, Switzerland). Arch. Pathol. Anat. Physiol., 334: 206-35(1961).

The kidneys of rabbits were locally irradiated with 4000 to 10000-r doses of 60- or 250-kv x rays, and histologic studies and tests of renal function were conducted from 9 days to 20 months later. A chronic, markedly progressive contracted kidney with severe nephrosis, especially of the distal tubular sections, was produced. The kidney changes were accompanied by a distal tubular syndrome characterized by retention of phenol red, electrolyte disturbances, anemia, hypertension, renal osteopathy, and terminal uremia. After an early stage of swelling, the kidney shrunk to $\frac{3}{5}$ of its normal weight by 1 to $1\frac{1}{2}$ months later. Papillary neurosis and pyelonephritis were evident in some cases. Striking was the high radiation resistance of the glomerulus. A distinct difference between the behavior of renal tissue of irradiated rabbit and human kidney was noted. Human kidneys show chiefly glomerular injuries, rabbit predominantly tubular lesions. Vascular and glomerular lesions arose only when the highest radiation dosage was employed or when extraradiation factors, such as hypertension, inflammation, and edema, were implicated. At late periods, fibrosis was the principal feature of the markedly shrunken kidney. (H.H.D.)

24911 THE EFFECT OF OXYGEN BREATHING AND RADIOTHERAPY UPON THE TISSUE OXYGEN TENSION OF SOME HUMAN TUMOURS. N. T. S. Evans (Hammersmith Hospital, London) and P. F. D. Naylor. Brit. J. Radiol., 36: 418-25(June 1963).

Measurements of tissue oxygen tension were made in human tumors which were being treated by high pressure oxygen radiotherapy. The measurements were made polarographically using a pulsed-voltage, membrane-covered electrode system. The electrodes measure mean oxygen tension over a circular area of 200 μ in diameter every 17 seconds. While the patients were breathing air the mean oxygen tensions recorded in their tumors showed a very large scatter. In one patient's tumor which was studied the tension varied from 0 to 100 mm Hg. Breathing 100 per cent oxygen at one atmosphere usually but not always produced an increase in oxygen tension. Breathing 100 per cent oxygen at four atmospheres produced an increase in oxygen tension in all of the tumor sites which were studied. Following irradiation there was an increase in tumor oxygen tension both while breathing air and 100 per cent oxygen at one atmosphere. The increase was, however, barely significant at the 5 per cent level. The rate of saturation of the tumors with oxygen was often slower than in normal skin. There was no systematic change following radiotherapy. Measurements of oxygen tension at one site in a tumor give no information concerning the oxygen tension at other sites. This emphasizes the lack of homogeneity of the vascular pattern in tumors. (auth)

24912 MEGAVOLTAGE TREATMENT PLANNING AND THE USE OF XERORADIOGRAPHY. F. T. Farmer, J. F. Fowler, and J. W. Haggith (Royal Victoria Infirmary, Newcastle-upon-Tyne, Eng.). Brit. J. Radiol., 36: 426-35(June 1963).

The problem of viewing the emergent ray image from a Treatment Planning Simulator is met by the use of xeroradiography. With this a finished picture is obtained within 10 seconds of completion of the x-ray exposure, which may be studied as a basis of further beam adjustment, or photographed if desired. This technique has the advantage over film, not only of speed in processing, but of showing soft tissue detail, bone detail, air passages, and skin outline, all within the same x-ray exposure range. The simulator at Newcastle on Tyne is described and illustrations of its use in relation to the 4 Mev linear accelerator are given. (auth)

24913 THE ANGULAR DISTRIBUTION OF RADIATION SCATTERED FROM A PHANTOM EXPOSED TO 100–300 kvp X RAYS. C. K. Bomford and T. E. Burlin (Hammersmith Hospital, London). Brit. J. Radiol., 36: 436-9(June 1963).

Measurements of the angular distribution of radiation scattered from a phantom exposed to 100 to 300 kvp x-ray beams are presented and discussed. (auth)

24914 STUDIES ON THE PROTECTIVE EFFECT OF ALLOGENEIC MARROW GRAFTS IN THE RAT FOLLOWING WHOLE-BODY IRRADIATION AT DIFFERENT DOSE-RATES. V. Doreen Courtenay (Royal Cancer Hospital, London). Brit. J. Radiol., 36: 440-7(June 1963).

In rats exposed to large doses of whole-body radiation at three different dose-rates, transplantation of syngeneic and allogeneic marrow was used as a means of determining the dose levels at which the immune response to the foreign graft was suppressed. This was compared with the dose levels at which hemorrhagic death and intestinal death occurred. A dose of 800 r of x rays at 29 r/minute suppressed the immune response sufficiently to prevent hemorrhagic death in rats given allogeneic marrow. At a dose-rate of 1.4 r/minute and a dose of 1,600 r (γ rays), the largest dose that could be given without causing intestinal failure, allogeneic marrow was rejected. When the dose-rate was reduced to 0.28 r/minute, after a total dose of 2,870 r neither suppression of the immune response nor intestinal failure occurred. (auth)

24915 VOCAL CORD PARALYSIS OCCURRING 17 YEARS AFTER ESTRAVASATION OF THOROTRAST IN THE NECK. J. H. Gough (St. Thomas' Hospital, London). Brit. J. Radiol., 36: 451-2(June 1963).

A case is described where the extravasation of Thorotrast in the neck at carotid arteriography resulted 17 years later in paralysis of the ipsilateral vocal cord. (C.H.)

24916 PRODUCTION OF CALCIPHYLACTIC FACIAL, ESOPHAGEAL, AND MEDIASTINAL LESIONS BY COMBINED TREATMENT WITH DIHYDROTACHYSTEROL AND THORIUM DIOXIDE. Hans Selye, Giovanni Gentile, and Rene Veilleux (Université, Montreal). Brit. Med. J., 2: 1194-6(Nov. 4, 1961).

Rats were sensitized by a single oral dose of dihydrotachysterol (DHT) and 24 hr later challenged by a single intravenous injection of a ThO_2 suspension (Thorotrast). The treatment induced multiple foci of calcification, connective tissue proliferation, and infiltration with inflam-

matory cells, among which eosinophils and pseudoeosinophils predominated. The lesions tended to be selectively localized in the facial skin, soft palate, palatine arches, base of the tongue, esophagus, and mediastinal connective-tissue. The cutaneous changes thus produced resemble the calcareous form of scleroderma. Although heavy deposits of ThO_2 were microscopically visible in liver Kupffer cells and splenic phagocytes, calcium deposition never occurred in the liver and only occasionally in the periphery of the splenic Malpighian follicles. The lesions were accompanied by an intense acute osteitis fibrosa characterized by pronounced bone absorption with an abundance of osteoclasts, and fibrosis in the bone marrow. The bones of the rats treated with DHT alone showed no comparable lesions. The bone lesions result from an acute transposition of calcium from the skeleton into the affected soft tissues. The cutaneous lesions resemble the calcareous form of scleroderma. (H.H.D.)

24917 THE EFFECTS OF NATIVE WILD-TYPE DEOXYRIBONUCLEIC ACID ON THE FREQUENCY OF BACK-MUTATION (REVERSION) INDUCED BY X-RAYS IN A THYMINE AND URACIL-REQUIRING MUTANT OF E. COLI (E. COLI 15 T^-U^-). O. Djordjević and D. Kanazir. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 43-51(Jan. 1963). (In English)

A study was made of the effect of x rays and native, probably biologically active, deoxyribonucleic acid (DNA) prepared from the autotrophic culture of E. coli, upon the frequency of back-mutation in the auxotrophic thymine and uracil-requiring mutant (E. coli 15 T^-U^-). It was found that x rays can produce reversion in this mutant-strain, and autotrophic revertants (E. coli 15 T^+U^+) can be isolated after such treatment. The frequency of appearance of the revertants considerably increases if the mutant cultures are treated with native (highly-polymerized) isologous DNA prepared from autotrophic bacteria (E. coli 15) immediately after irradiation. This effect seems to be specific, because it has not been observed after treating the irradiated mutants with homologous and heterologous DNA, yeast RNA, and Bacto-peptone (Difco). The possible mechanism(s) of the effect of DNA on the process(s) of back mutation (reversion) induced by irradiation, is discussed. (auth)

24918 THE EFFECT OF X-IRRADIATION ON THE TRANSAMINASE ACTIVITY IN TISSUES OF INFANTILE RATS. M. M. Jovanović and N. B. Svećenski. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 53-6(Jan. 1963). (In English)

The transaminase activity in some organs of mammals is increased. Cortisone and ACTH also exert an influence upon the transaminase activity, and it is assumed that an unspecific stress reaction is responsible for this. (auth)

24919 IMMEDIATE EFFECT OF X RADIATION ON THE CYTOPLASMIC STREAMING OF NITELLA FLEXILIS AG. Claude Gillet. Bull. Classe Sci., Acad. Roy. Belg. (5), 48: 1161-8(1962). (In French)

The irradiation of internodal cells of Nitella flexilis by 50 or 500 kr caused a momentary arrest of cytoplasmic streaming. After irradiation, the cyclosis velocity increased first following an exponential law, and then slowed so that after an hour it reached a constant value. The different modalities in the re-establishment of the cytoplasmic streaming depended on the dose received. The different accelerations of cyclosis after irradiation seemed to be determined by the kinetics of the reactions following restoration in the structural organization of the protoplasm. (tr-auth)

24920 CHANGES IN HEREDITY AND IN SOME PHYSIOLOGICAL AND BIOCHEMICAL INDICES UNDER THE EFFECT OF RADIOACTIVE IODINE 131. B. Eftimov, G. Konstantinov, D. Alexiev, and B. Amov. Compt. Rend. Acad. Bulgare Sci., 16: 89-92(1963).

Experiments were carried out on nine rabbits of three different breeds of thoroughbreds. Iodine-131 was injected in the rabbits. From the results it was concluded that a change in metabolism due to I^{131} causes changes in the reproductive capacity and in heredity of rabbits. (P.C.H.)

24921 MODIFICATION OF THE VELOCITY OF CYTOPLASMIC STREAMING, INDUCED AT A DISTANCE, BY IRRADIATION IN NITELLA FLEXILIS. C. Gillet (Institut de Morphologie Végétale and Laboratoire de Recherches pour la Protection des Populations Civiles, Liège). Experientia, 19: 198-9(1963). (In French)

Irradiation of an internodal cell of Nitella flexilis induces in the adjacent internodal cell a transitory acceleration of the cytoplasmic streaming. For at least 8 hr the streaming speed is higher than in control internodal cells. It is probable that this phenomenon is due to the transfer of certain substances from the irradiated cell. (auth)

24922 THE EFFECT OF RADIATION ON THE MITOSIS-STIMULATING ACTIVITY OF HEPATECTOMIZED RAT SERUM. M. Šilha (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Experientia, 19: 226-7(1963). (In English)

Studies were made on the mitosis-stimulating factor in the serum of partially hepatectomized rats x irradiated for 20 hr with a dose of 700 r. It was preliminarily concluded that radiation reduces the mitosis-stimulating activity of serum. (P.C.H.)

24923 WEIGHT OF RAT EMBRYOS AFTER X-RAY IRRADIATION. N. Skreb, N. Bijelić, and G. Luković (Faculty of Medicine, Zagreb). Experientia, 19: 263-4 (1963). (In English)

Rat embryos were x irradiated with a dose of 100 r from the 5th to the 10th day of gestation. All treated animals were killed on the 15th day of pregnancy and the embryos weighed after fixation in Bouin's mixture. In all irradiated groups the mean fetal weights were significantly lower than in controls, but there was also a significant difference between the irradiated groups. It was concluded that irradiation damage, measured by fetal weight, is greater during the mesoderm formation than before or after it. (P.C.H.)

24924 DNA SYNTHESIS IN X-IRRADIATED CULTURES INFECTED WITH POLYOMA VIRUS. J. Minowada and G. E. Moore (Roswell Park Memorial Inst., Buffalo). Exptl. Cell Res., 29: 31-5(Jan. 1963).

The growth synthesis of polyoma virus and DNA synthesis in the polyoma-infected and non-infected mouse-embryo cultures, which had been x irradiated at 10000 or 2000 r on 1 or 2 days before virus inoculation, were studied by means of autoradiography using H^3-thymidine. The x irradiated cultures supported efficiently virus multiplication with typical and rapid cytopathogenic effects. These observations were essentially the same as observed in the nonirradiated infected cultures. DNA synthesis of the infected cultures in both radiation levels was found to a marked extent with appreciable degree of virus multiplication. The results indicate that an increased DNA synthesis obtained in the x irradiated infected cultures represents mainly newly synthesized viral DNA. (P.C.H.)

24925 CATHEPSIN C AND ULTRAVIOLET MEDIATED INHIBITION OF MITOCHONDRIAL REACTIONS. R. E. Beyer (Tufts Univ., Boston). Exptl. Cell Res., 29: 212-19(Jan. 1963).

The relation between ultraviolet inactivation of mito-

chrondrial dinitrophenol-activated adenosinetriphosphatase and cathepsin C activity contained in the preparation was studied. It was indicated that far-ultraviolet activation of lysosomal cathepsin C acting upon mitochondrial protein is probably not the basis of previously noted inactivation of mitochondrial enzyme systems following ultraviolet irradiation. Incubation of mitochondria with purified beef spleen cathepsin under conditions previously employed for ultraviolet treatment does not result in a loss of adenosinetriphosphatase activity. Ultraviolet irradiation of the mitochondrial fraction results in a drop of adenosinetriphosphatase activity at the same time as cathepsin is being photoinactivated. Also, cathepsin inhibitors do not protect mitochondria from inactivation by far-ultraviolet light. (P.C.H.)

24926 CHANGES IN CELLULAR PERMEABILITY OF DIFFERENT COATS OF ALLIUM CEPA L AFTER X-RAY IRRADIATION. V. Srb and B. Hluchovský (Charles Univ., Prague). Exptl. Cell Res., 29: 261-7(Jan. 1963).

Using the plasmolytic method (plasmolytic agent: 0.5 M KNO_3, pH 5) the effects of a dose of 1000 + 44 r x radiation on the changes in cellular permeability in different coats of onions Allium cepa L (Všetaty seedling) were studied in the course of 40 or 42 days following irradiation. It was concluded that ionizing x radiation affects the permeability of epidermal cells of all four examined coats of onions Allium cepa L without exception. Changes in the permeability of the individual coats in the course of 40 or 42 days following irradiation were irregular and difficult to explain. In spite of certain physiological differences in the single coats, their basic reaction on electrolytic plasmolytic agents was the same, the onset of complete plasmolysis was always delayed as compared with the controls. (P.C.H.)

24927 CYTOLOGICAL ANALYSIS OF COLONIES DEVELOPED FROM MAMMALIAN CELLS IRRADIATED IN VITRO WITH X-RAYS. G. Colombo and G. Marin (Universitá, Perugia, Italy and Universitá, Padua). Exptl. Cell Res., 29: 268-77(Jan. 1963).

The relation between x-ray induced reproductive death and blockage of cell division leading to giant cell formation was studied on a strain of mammalian cells grown in vitro. The size and morphology of colonies developed from single-cell platings were recorded from samples fixed and stained every second day, up to 8 days after irradiation with 150, 300, and 450 r. Early appearance of giant cells in the progenies of irradiated cells was followed by delayed loss of colonies. Since loss affected mainly the colonies with giant cells, the presence of giants turned out to be a morphological expression of some kind of lethal damage carried in the clones. Therefore giant cell formation and reproductive death could be ascribed to the same hereditable damage, although some minor lethality appeared to be related to a different mechanism. (auth)

24928 THE RADIOLOGICAL RELEASED CEREBRAL EDEMA AND ITS PREVENTION. PART I. EXPERIMENTAL ANIMAL INVESTIGATIONS. S. Wende (Freie Universität, Berlin). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 98: 589-93(1963). (In German)

The initiation and course of radioinduced cerebral changes was investigated in experimental animals by means of the gamma encephalogram. The findings were interpreted as being due to damage to blood vessel walls with consecutive disturbance of the blood-brain barrier. A dose and effect relation shows a regular behavior. The effect of cerebral irradiation in rabbits with 1500 r could be modified by the use of Aescin, in the form of the commercial preparation Reparil. This resulted in the prevention or reduction of cerebral edema. (auth)

24929 SOME EFFECTS OF LONG-TERM ALPHA IRRADIATION ON THE COMPOSITION AND STRUCTURE OF BONE. Betsy J. Stover and W. S. S. Jee (Univ. of Utah, Salt Lake City). Health Phys., 9: 267-75(Mar. 1963). (In English)

Comparison of selected skeletal samples from healthy adult beagles and beagles given about 3 μc Pu^{239}/kg several years prior to sacrifice showed significant differences in relative water, organic, and inorganic contents but not in the relative amounts of calcium and phosphate in bone mineral. These differences correlate with histological and microradiographic observations of changes in cellularity, hypo-, and hypermineralization, and loss of osseous tissue. A few changes in relative bone composition with age were observed. (auth)

24930 SLIDE RULE FOR DETERMINATION OF DOSE DELIVERED TO ORGAN AFTER A SINGLE ABSORPTION. G. Vacca (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses, France). Health Phys., 9: 343-4(Mar. 1963). (In French)

A rapid slide-rule method is described for estimating the radiation dose to organs after inhalation or ingestion of radioactive materials. The method can also be used to estimate the dose delivered from radioisotopes injected intravenously or intramuscularly. (C.H.)

24931 REPORT OF THE RBE COMMITTEE TO THE INTERNATIONAL COMMISSIONS ON RADIOLOGICAL PROTECTION AND ON RADIOLOGICAL UNITS AND MEASUREMENTS. Health Phys., 9: 357-86(Apr. 1963). (In English)

A review was made of the concept and use of RBE (relative biological effectiveness) and its application in radiation protection work. The conclusion reached is that there is no justification at the present time for departing from present ICRP practice, including the current relationship between RBE and Linear Energy Transfer (LET). However, the extent of the data on RBE relevant to low dose and low dose-rate conditions is very small indeed and major modifications in the concept and use of RBE in protection considerations may well become necessary in the future. It is recommended that the term RBE as used in protection work should be replaced by QF ("Quality Factor"). It is also recommended that the table of QF values (Table) should be related only to LET in water and that data on specific ionization (ion pairs/μ) be omitted, since very little precision can be claimed for this quantity.

TABLE. LET–QF RELATIONSHIP

LET_∞ (kev/μ in water)	QF
3.5 or less	1
3.5–7.0	1–2
7.0–23	2–5
23–53	5–10
53–175	10–20

LET_∞ is equal to the stopping power in water. This Table implies that the QF for x and gamma rays is in practice close to unity and for electrons is only greater than unity at very low energies, which is in accordance with present usage. (auth)

24932 FURTHER STUDIES ON LUNG CANCER FROM $Ce^{144}F_3$. Herman Cember (Univ. of Cincinnati). Health Phys., 9: 539-44(May 1963). (In English)

Cerium-144 as 1 μ-diameter $Ce^{144}F_3$ particulates produced lung cancer in rats when intratracheally injected at dose levels of 0.5, 1, 2, and 4 μc. The tumor frequency in each of these treatment levels was 8/41, 6/44, 4/34, and 14/42, respectively. In the lowest dose level, the first death due to lung cancer, a lymph osarcoma, occurred 528 days after exposure. The radiation dose to the lungs in this case was 600 rad. Insofar as extrapolation of these experimental data to man is valid, the results of this experiment imply that the radiotoxicity of atmospheric Ce^{144} is greater than that assumed at the present time. (auth)

24933 EUROPEAN MEETING ON THE MICROBIOLOGY OF IRRADIATED FOODS, PARIS, 20-23 APRIL 1960. Intern. J. Appl. Radiation Isotopes, 14: 1-58(Jan. 1963).

Nine papers are presented on topics relating to radiosterilization of foods and to radiation effects on microorganisms. Separate abstracts were prepared for eight of the papers; the remaining paper was previously abstracted in NSA. A report of the conclusions and recommendations reached at the meeting is also included. (D.L.C.)

24934 DOSE REQUIREMENTS FOR THE RADIATION STERILIZATION OF FOOD. C. F. Schmidt (Continental Can Co. Inc., Chicago). Intern. J. Appl. Radiation Isotopes, 14: 19-26(Jan. 1963). (In English)

The greater radiation resistance of Cl. botulinum relative to the spores of spoilage organisms means that the dose required for safety against Cl. botulinum will determine the minimum sterilization requirements. A review is presented of measurements of the radiation resistance of bacterial spores. Some of the results for Cl. botulinum are given, and it is shown that the experimental and calculated dose requirements for sterility are in good agreement. (D.L.C.)

24935 TECHNOLOGICAL ASPECTS OF THE RADIATION PASTEURIZATION OF FOODS. C. F. Niven, Jr. (American Meat Inst. Foundation, Chicago). Intern J. Appl. Radiation Isotopes, 14: 26-9(Jan. 1963). (In English)

A review is presented of the radiation preservation of foods and its probable use in the future. Radiation preservation probably will be applied to foods not easily preserved by other means, such as fresh meat, but undesirable flavors are a problem. The application of radiation preservation in conjunction with other methods, e.g., antibiotics, are considered. The research needed to be done on radiation preservation is described briefly. (D.L.C.)

24936 MICROORGANISMS RESISTANT TO IONIZING RADIATION. P. Dupuy (Institut National de la Recherche Agronomique, Versailles, France). Intern. J. Appl. Radiation Isotopes, 14: 29-35(Jan. 1963). (In French)

The establishment of a scale of radiation resistance of microörganisms is discussed. Attention is given to several organisms that exhibit exceptional radiation resistance. The idea of the possibility of induction of radiation resistance in a given species is examined. A bibliography of 42 references is given. (T.F.H.)

24937 INFLUENCE OF THE KIND OF RADIATION ON THE INACTIVATION OF MICROORGANISMS. P. Bonet-Maury (Université, Paris). Intern. J. Appl. Radiation Isotopes, 14: 36-8(Jan. 1963). (In French)

The inactivation and sterilization of microörganisms by radiation are reviewed. Beta, gamma, x, neutron, fast-neutron, deuteron, proton, and alpha irradiations are considered. Attention is also given to the effects of radiation on materials, and to the economic and industrial uses of radiations. (T.F.H.)

24938 THE INFLUENCE OF DOSE RATE ON THE INACTIVATION OF MICRO-ORGANISMS. F. J. Ley (Atomic Energy Research Establishment, Wantage, Berks, Eng.). Intern. J. Appl. Radiation Isotopes, 14: 38-41(Jan. 1963). (In English)

A review is presented of work relating to the effects of dose rate on the radioinduced inactivation of microorganisms. The results in general are contradictory. The oxygen effect and the use of ultra-short radiation bursts are considered. (D.L.C.)

24939 INFLUENCE OF THE KIND OF AMBIENT ENVIRONMENT DURING IRRADIATION ON THE SURVIVAL OF BACTERIA. S. Davydoff-Alibert (Commissariat à l'Énergie Atomique, Paris). Intern. J. Appl. Radiation Isotopes, 14: 41-4(Jan. 1963). (In French)

The effects of oxygen content, radioprotective agents, water content, and temperature on the radiosterilization of microorganisms are studied. (T.F.H.)

24940 COMBINATION PROCESSES. Margaret J. Thornley and M. Ingram (Low Temperature Research Station, Cambridge, Eng.). Intern. J. Appl. Radiation Isotopes, 14: 45-8(Jan. 1963). (In English)

A brief discussion is presented of possible combinations of radiation with other processes in the sterilization of foods, and of the research needed to be done on such combinations. The processes considered are intermittent irradiation, pre-cooking, cooking after irradiation, addition of foreign substances (curing ingredients, chemicals, and antibiotics), and refrigeration. (D.L.C.)

24941 CONDITIONS AFTER IRRADIATION AFFECTING SURVIVAL AND RECOVERY OF MICRO-ORGANISMS. B. A. Bridges (Atomic Energy Research Establishment, Wantage, Berks, Eng.). Intern. J. Appl. Radiation Isotopes, 14: 48-51(Jan. 1963). (In English)

A brief review is presented of the work on the effects of post-irradiation growth media and temperature on the survival of microorganisms. The question of possible recovery of organisms in irradiated food is considered, and some of the needed studies are described briefly. (D.L.C.)

24942 THE EFFECT OF COSMIC FLIGHT FACTORS OF "VOSTOK-2" UPON MICROORGANISMS: STUDIES ON YEASTS OF DIFFERENT PLOIDY. N. V. Koviazin, A. A. Lukin, and G. P. Parfenov. Iskusstv. Sputniki Zemli, Akad. Nauk SSSR, 13: 123-9(1962). (In Russian)

Cosmic flights on "Vostok-2" had no effect upon haploid or diploid yeast cells in an aqueous medium in hermetically sealed glass ampules. Oleic acid (slightly acidulated), if added to the medium in very low concentration, will increase the sensitivity to cosmic rays in haploid cells (50% died) without affecting the diploid cells. In higher concentrations it was less effective as evidenced by the greater number of surviving haploid cells. (Aerospace Med., 34: 5)

24943 THE EFFECT OF A MEDIUM DOSE (430 ROENTGENS) OF X RAY IRRADIATION ON RESTING CELLS OF THE LIVER. Antoni Horst and Tadeusz Rudnicki (Medical Academy, Poznan, Poland). J. Cell. Biol., 13: 261-8(May 1962).

In rats subjected to partial hepatectomy the mitotic activity of regenerating liver cells after a single 430-r dose of x irradiation was studied. The mitotic index and the number of abnormal mitotic figures were determined. The results indicated that resting cells irradiated a short time before mitotic activity show reactions similar to those of cells irradiated during mitotic activity. The disturbances

in the irradiated mitotically active cells were only quantitatively different from those in the irradiated resting cells. The disturbances in the irradiated resting cells depended upon the time interval between irradiation and the beginning of mitotic activity stimulated by partial hepatectomy: the shorter the time interval, the more pronounced were the disturbances and the more similar they became to those of irradiated mitotically active cells. It is suggested that such lesions are not merely revealed by the process of mitosis but that mitosis renders it possible for the lesions to develop. (TCO)

24944 CAN THE MAMMALIAN EMBRYO BE KILLED BY X IRRADIATION? Roberts Rugh and Marlis Wohlfromm (Columbia Univ., New York). J. Exptl. Zool., 151: 227-43 (Dec. 1962).

In CF1 mice, 1181 pregnancies and 11,825 implantations were used to determine the dose of x rays that would kill 50% of their embryos studied from the 1st to 17th days of gestation. The extrapolated LD_{50} values varied from 100 r at fertilization to 800 r on the 18th day. Embryos x irradiated from 0.0 to 9.0 days were found to be relatively more sensitive than those x irradiated during the second half of pregnancy. The greatest radiosensitivity occurred at 0.0, 2.0, 3.0, 7.0, and 8.0 days, with 0.0 and 8.0 being the most vulnerable. Embryos at 6 days were relatively resistant. The periods of maximum radiosensitivity occurred during syngamy, the morula stage, and neurogenesis. The embryonic period of greatest resistance was at implantation and gastrulation. The implantation number was not appreciably affected by x rays except at 0.5 days when the litter number average dropped from the control level of 9.86 to 7.89 after an exposure of 250 r. This probably indicated high mortality in the very early stages of cleavage, leaving no implantation residue. The data on survival, therefore, relate to implantation numbers so that the extrapolated LD_{50} for the early (0.5-day) embryo is probably much too high. Irradiated early embryos rarely survive to die as fetuses, but die quickly to leave a resorption mass that persists. Embryos rarely die as fetuses except when x irradiated after day 7.0. Congenital anomalies resulted from exposure at almost every gestation age. The most consistent and frequent result of embryonic or fetal x irradiation was stunting. Except during the period of 10 to 13 days, when there were many accompanying anomalies, there appeared to be little alteration in the topography of the stunted fetuses. It was concluded that no value can be ascribed to the LD_{50} for the embryo because there is no such static entity. (TCO)

24945 COMPARISON OF THE RADIATION SENSITIVITY OF CELLS OF THIOBACILLUS NOVELLUS WHEN GROWN AND RECOVERED ON AUTOTROPHIC AND SAPROPHYTIC MEDIA. Ubolsri Cheosakul (Massachusetts Inst. of Tech., Cambridge). J. Natl. Res. Council Thailand, Pt. I, 3: No. 1, 1-37(Mar. 1962). (In English)

Thiobacillus novellus, a facultative autotroph, was grown on both autotrophic and saprophytic (TGE) media and, after irradiation in either air or nitrogen, was recovered by plating on the same media. The two major factors found to influence resistivity toward ionizing radiation were the growth media and the presence or absence of air during irradiation. Cells grown on TGE agar were more resistant than cells grown on autotrophic agar. Analysis of the relations between survival fractions and dose on these fundamentally different media indicates that for this organism sulfur metabolism may be implicated in radioresistivity and that this or some related metabolic system is more sensitive to ionizing radiation in the presence of air than in a nitrogen atmosphere. (auth)

24946 A RADIATION-INDUCED VARIANT OF THE CESTODE, HYMENOLEPIS DIMINUTA, WITH TWO-HOOKED ONCOSPHERES. Arthur W. Jones and James A. Dvorak (Univ. of Tennessee, Knoxville). J. Tenn. Acad. Sci., 38: 26-31(Jan. 1963).

A radioinduced variant of a cestode, which by inheritance is a member of the common species, Hymenolepid diminuta, but by structure is unique, differing in one respect, its 2-hooked oncospheres, from all other members of the species, is described. Also, the mutant form was smaller and more slender than the normal and had relatively longer and fewer proglottids and fewer eggs. The chromosomes differed from normal chromosomes in morphology but not in number, there being evidence of translocation of chromosomal segments. The mutant form is considered an example of a genetically significant anomaly, potentially a taxonomic problem. (P.C.H.)

24947 EARLY EFFECTS OF X IRRADIATION ON THE PERMEABILITY OF EXCISED AND LIVING AORTA WALL. R. Brinkman, H. B. Lamberts, and J. K. Bottema (Univ. of Groningen, Netherlands). Koninkl. Ned. Akad. Wetenschap., Proc., Ser. C, 64: 449-53(1960).

Experiments are reported that demonstrate an increase of permeability of aortic tissue after irradiation, presumably as a result of the depolymerization of mucopolysaccharides (MPS). A drop in injection pressure of the aorta followed irradiation with 500 r. The increased permeability of irradiated aorta could also be demonstrated by a dye technique in which infiltration of trypan blue into the intima was demonstrated. Penetration of dye following irradiation was diminished if physiologic pressure in the lumen was maintained. In rats the increased aortic infiltration could be demonstrated readily. If the rat received 1000 to 3000 r whole-body x irradiation, was injected 10 min later intravenously with 0.4 ml/100 g of a 1% solution of Congo red in 5% glucose, and was killed after 30 min, the aorta of the irradiated rat was distinctly more stained than that of non-irradiated animals, indicating increased macromolecular infiltration through the mucopolysaccharide barrier. If 1 mg/g sodium thiosulfate was given subcutaneously just before irradiation, the aorta was completely protected. No consistent protective effect was demonstrated with aminoethylisothiuronium, cysteamine, cystamine, or serotonin. (TCO)

24948 THE THYMUS AND LYMPH NODES IN RADIATION CHIMERAS. C. E. Ford and H. S. Micklem (Medical Research Council Radiobiological Research Unit, Harwell, Berks, Eng.). Lancet, I: 359-62(Feb. 16, 1963).

Lethally irradiated mice were injected with bone marrow, together with lymph-node or thymus cells. The progeny of the bone-marrow and lymphoid inocula could be distinguished from each other and from cells of the host by means of chromosome markers. An inbred strain (CBA-T6T6) was used that is entirely compatible with strain CBA/H. Hematopoietic cell populations from CBA-T6T6 and (CBA x CBA-T6T6)F_1 donors grow in lethally irradiated CBA hosts. CBA male mice were given 1000-rad whole-body x irradiation, and were injected intravenously with CBA-T6T6 cells. Donor cells could be distinguished by the distinctive small T6 chromosome. Bone-marrow cells clearly had a greater ability to proliferate in the tissues studied than cells of lymph node or thymus. Injected lymphoid cells proliferated more extensively in the lymph nodes than in the thymus, although even in the nodes they were never in the majority of

dividing cells. Subsequently the nodes of most animals showed good lymphoid regeneration, with typical germinal centers in the mesenteric nodes. Reformation of lymphoid elements was far more advanced in the thymus than in the lymph nodes by 3 weeks after irradiation. It was concluded that there is something in the structure of the thymus which positively prevents the ingress of intravenously injected lymphoid cells. The observations show that the re-formation of lymphoid elements occurs sooner in the thymus than in the lymph nodes, and are compatible with the idea that the thymus continues to seed the other lymphoid tissues. They further show that the precursors of the thymus own regeneration after irradiation comes from the injected bone marrow. (TCO)

24949 THE EFFECT OF IONIZING RADIATION ON STRAIN L MONOLAYERS. I. CYTOLOGICAL ABERRATIONS AND CELL MULTIPLICATION. Roland M. Nardone (Catholic Univ. of America, Washington, D. C.). Life Sci., No. 2: 113-19(Feb. 1963).

A study was made of cytological aberrations caused by exposure of cells to 500, 1000, and 1500-r doses of Co^{60} γ rays at a rate of 1332 r/hr. The changes include cytoplasmic vacuolization, nuclear blistering, amitotic division, and giant-cell formation. An analysis of the effect of dose and postirradiation time on the mitotic index, and on the frequency of multinucleate cells and those with blistered nuclei, showed that the full impact of such high doses of radiation is not immediately manifested. The incidence of abnormal nuclei and the inhibition of mitosis are related to dose and time after irradiation. The irradiated cultures had a higher frequency of multinucleate cells than was found in nonirradiated cultures. However, the aberration could not be correlated with dose. The most evident cytoplasmic modifications were nuclear blistering and giant cell formation. The effects of 100- to 3000-r doses on growth of such populations were also studied. Only the 3000-r dose prevented an increase in cell number; all other doses resulted in a temporary cessation of population growth. The slopes of the growth curves of the 100- to 1000-r cultures were very similar despite the accumulation of gross cytological abnormalities in the cultures irradiated with 500 and 100 r. Despite such gross nuclear abnormalities as blistering in some of its members, the 500-r population was able to increase at a rate close to that of the nonirradiated population, although the growth rate of cultures irradiated with more than 500 r was proportionately depressed. The differences are discussed. (TCO)

24950 INTRATISSULAR ADMINISTRATION OF RADIOPHOSPHORUS IN THE FORM OF COLLOIDAL CHROMIUM PHOSPHATE (EXPERIMENTAL RESEARCH). L. E. Pakulina (Inst. of Oncology, Academy of Medical Sciences, USSR). Med. Radiol., 8: No. 4, 17-22(Apr. 1963). (In Russian)

Experiments on rats demonstrated that a radioactive colloidal solution of chromium phosphate has a high penetrating capacity in intramuscular administration. The doses at the site of isotope administration were calculated as well as doses in the internal organs of animals. Note is made of the hazard of introduction of the solution within the tissues in view of the possibility of creating high doses of beta rays in the internal organs. (auth)

24951 MORPHOLOGICAL CHANGES IN THE LUNGS IN X-RAY THERAPY. E. D. Savchenko and T. A. Tretyakova (Scientific-Research Inst. of Roentgen-Radiology, Ministry of Health, USSR and Central Graduate School of Medicine, USSR). Med. Radiol., 8: No. 4, 33-42(Apr. 1963). (In Russian)

Radiation reactions were studied in the lungs of patients subjected to x-ray therapy for cancer of the esophagus. Morphological changes in the lungs and pleura show a diverse picture depending on the time of death of patients (at the beginning of irradiation or several months after its termination). At early periods there is seen a prevalence of inflammatory changes, elevated permeability of vascular walls, and bronchial occlusion. At late periods there are observed marked pneumosclerotic changes. Supervention of secondary infection complicates the course of radiation reactions and may lead to the patient's death with manifestations of cardiopulmonary insufficiency. In view of this in radiation reactions in the lungs it is expedient to undertake an early antibiotic, cardiac, and pulmonary therapy. (auth)

24952 CHANGES OF THE DENTOMAXILLARY SYSTEM IN MULTIPLE X-RAY IRRADIATION. A. A. Prokhonchukov and V. V. Panikarovskii (Moscow Medical Stomatological Inst.). Med. Radiol., 8: No. 4, 47-53(Apr. 1963). (In Russian)

Studies were made on the influence of repeated x irradiation on the dentomaxillary system in albino rats. Single doses averaged 25, 50, and 100 r, the total dose amounting to 3500 r. The depth of radiation changes in the jaws and teeth depended on the value of total x-ray doses. In the action of total doses (1,200 to 1,600 r) at first the mucous membrane became involved, whereby higher doses (3,500 r) caused affection of the teeth and bone tissue of jaws. Edema, hemorrhages, gingivitis, and ulcerative-necrotic changes were noted in the mucous membrane. The dental pulp showed blood congestion, edema, fibrosclerosis, and reticular atrophy, pycnosis, and vacuolization of odontoblast nuclei, and sometimes necrosis of the pulp. The bone tissue of the jaws, along with resorption of the bone with the participation mostly of macrophages (osteoclasts rarely), processes of bone tissue regeneration were observed with the participation of osteoblasts. (P.C.H.)

24953 THE COURSE OF ACUTE INTESTINAL INFECTIONS IN MONKEYS DURING THE ACTION OF IONISING RADIATION. Z. K. Stasilevich (Inst. of Experimental Pathology and Therapy, Academy of Medical Sciences, USSR). Med. Radiol., 8: No. 4, 53-7(Apr. 1963). (In Russian)

The influence of sublethal x irradiation on the susceptibility of monkeys to acute intestinal infections (paratyphoid B fever, Heidelberg's salmonellosis and colienteritis) was studied. Experiments were carried out on 46 macaque monkeys, aged 2½ to 3 yr. In monkeys subjected to a dose of 300 r there was an elevated susceptibility to paratyphoid B fever; however, the infectious process was not aggravated. Irradiation of animals with a similar dose aggravated the infectious process in Heidelberg's salmonellosis. In monkeys with colienteritis the above dose did not influence the natural immunity of animals to this disease. A clinically marked disease (colienteritis), with a lethal outcome was induced in monkeys irradiated with a dose of 445 r. (auth)

24954 THE INFLUENCE OF X-RAY IRRADIATION ON THE REPRODUCTIVE FUNCTION IN DOGS AND THEIR PROGENY OF THE FIRST GENERATION. I. Ya. Voznyuk (Kishinev Medical Inst., USSR). Med. Radiol., 8: No. 4, 62-7(Apr. 1963). (In Russian)

Investigations were made on the influence of x radiation on the reproductive function of dogs and their progeny in single whole-body irradiation at the end of pregnancy in a dose of 350 to 400 r. In 73.1% of irradiated dogs no disturbances of the estral cycle were observed. Repeated pregnancy and labor were normal. Twelve dogs (23%), which had sustained radiation sickness, developed sterility; how-

ever, the estral cycle in 8 dogs was restored in 2 to 3 years. In 5 dogs gestation terminated in abortion. In young female dogs irradiated before birth the sexual reflex was inhibited. The estral stage in the dogs appeared at the age of 2 to 3 years and pregnancy ensued in only 4 dogs out of 15. The dogs gave birth to only 2 to 3 puppies: all of which were nonviable with marked developmental abnormalities and monstrosities. (auth)

24955 GLUCURONIDE EXCRETION AND THE DETOXICATION MECHANISM IN WHOLE-BODY IRRADIATED RATS. Jorge Chiriboga (UT-AEC agricultural Research Lab., Oak Ridge, Tenn.). Nature, 198: 803-4 (May 25, 1963).

Urinary glucuronide excretion was diminished in rats after exposure to 1,000 r whole-body γ radiation, while sensitivity to naphthalene was increased. Details of the analytical methods are presented. The significance of the observations is discussed. (C.H.)

24956 SYNTHESIS OF DEOXYRIBONUCLEIC ACID AS A FUNCTION OF THE RADIATION DOSE TO THE LIVER IN PARTIALLY HEPATECTOMIZED RATS. W. B. Looney, M. L. Pardue, and F. W. Banghart (Univ. of Virginia, Charlottesville). Nature, 198: 804-5(May 25, 1963).

Quantitative radioautographic studies were made of the dose-response of desoxyribonucleic acid synthesis in the liver of rats exposed to x radiation. Thymidine-H^3 was used as a tracer for DNA synthesis. Results are compared with those from similar dose-response studies of radiation effects in a number of in vivo and in vitro systems. (C.H.)

24957 CHANGE IN THE VISCOSITY OF THE MEDIUM AFTER IRRADIATION OF BACTERIA WITH ULTRAVIOLET LIGHT. C. N. Murty and A. Guha (Banaras Hindu Univ., Varanasi, India). Nature, 198: 902-3(June 1, 1963).

Changes in viscosity of the medium were observed after exposure of Escherichia coli in broth to ultraviolet light. The viscosity increased with dose up to 19,680 ergs/mm^2, and then decreased to a minimum value at 39,360 ergs/mm^2. Possible explanations are discussed. (C.H.)

24958 X IRRADIATION OF ISOLATED LIVER CELL NUCLEI. Hanna Ernst (Heiligenberg-Instituts, Ger.). Naturwissenschaften, 50: 227-8(1963). (In German)

Isolated liver cell nuclei of white rats were irradiated in saccharose solution, preserved at 2° with occasional shaking, centrifuged, and extracted with 0.14M NaCl and with 0.2N HCl. The protein nitrogen of both extracts was determined. The irradiation doses were 1, 5, 10, 20, and 30 kr, and the extraction was made one hour after irradiation. For a three-hour delay between irradiation and extraction, doses of 10, 20, and 30 kr were used. No concentration decrease was established in the in vitro cells. The DNA showed no radiochemical decomposition. The enzymatic decomposition of these cells was studied, and no significant dose dependence was found. (J.S.R.)

24959 POST-IRRADIATION LEUKEMIA. REPORT OF THREE (3) CASES. Julian Blicharski, Jerzy Lisiewicz, Leslawa Szczeciakowska, and Maria Wazewska-Czyzewska (Third Clinic of Internal Diseases, Medical Academy, Krakow). Polski Tygodnik Lekar., 18: 384-7(Mar. 11, 1963).

A 1 yr follow-up study of 3 patients with leukemia is reported. All patients had a history of irradiation with large doses of x rays prior to onset of the disease. (TCO)

24960 INHIBITION OF THE IMMUNE RESPONSE BY CORTISONE, AND ITS POSSIBLE RELATION TO THE SIMILAR ACTION OF X RAYS AND ANTI-METABOLIC DRUGS. Nathan Kaliss (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Proc. Internat. Symposium Tissue Transplantation, Santiago, Chile, 20 Aug.–2 Sept. 1961, 87-100(1962).

Cortisone administered to mice during primary immunization inhibited the production of isoantibody (hemagglutinins). The inhibition initiated during primary immunization persisted for a prolonged period, as evidenced by the production of a very low titered antibody or no detectable antibody, after secondary immunization, this time without cortisone. Cortisone administered only during the period of secondary immunization had little or no inhibitory effect on isoantibody production. The data are in general agreement with the effects of x irradiation and some antimetabolic drugs on the immune response. The inhibitory effectiveness of the agents is dependent on the timing between their administration and injection of antigen, and on their relative dosages. This is most clearly shown with x irradiation and the method of cell transfer techniques. The data thus derived are consistent with the conclusion that 2 qualitatively different phases are involved in antibody formation, an inductive phase, during which the stage is set for antibody synthesis, but during which there is no detectable antibody formed, and a productive phase. The first phase is sensitive to radiation and radiomimetic drugs; the second phase is not. The influence of the agents on both antibody production and homograft survival is discussed. All 3 classes of immune-inhibitory agents, when administered by themselves, delay the homograft reaction, but do not completely abrogate it. (TCO)

24961 A STUDY OF THE EFFECT OF X-RAYS ON THE ELECTRICAL PROPERTIES OF MAMMALIAN NERVE AND MUSCLE. N. Allen and J. G. Nicholls (Oxford Univ.). Proc. Roy. Soc. (London), Ser. B, 157: 536-61(May 28, 1963).

Resting potentials, action potentials, and miniature end-plate potentials were recorded from isolated phrenic-diaphragm preparations of the rat during and after irradiation with x rays. Relatively small doses of a few thousand roentgens had no obvious effect on the preparation for many hours but larger doses, of the order of 70 to 150 kr irreversibly blocked neuromuscular transmission. Records made at the motor end-plate showed that the cause of the block is a presynaptic failure of impulse propagation in the intramuscular part of the nerve. The time course of the failure depends largely on the rate at which x rays are delivered to the preparation: at a high dose-rate (70 kr/min) the block develops rapidly and is accompanied by an increase in the frequency of miniature potentials; at a low dose-rate (7 kr/min) larger doses are required, the latency is longer and the miniature potentials continue at a normal frequency. The sequence in which different parts of the muscle become blocked, the abrupt nature of the failure at an individual motor end-plate, and the increase in frequency of the miniature potentials together suggest that the action of x rays is to block conduction in the nerve near its terminals. The results do not support the hypotheses that small doses of x rays at a high or a low dose-rate lead to an initial enhancement of function or that they produce immediate and reversible changes in the permeability of excitable membranes to ions. (P.C.H.)

24962 THE USE OF IONIZING RADIATION AS A MOTIVATING STIMULUS. J. Garcia, D. J. Kimeldorf, and E. L. Hunt (Naval Radiological Defense Lab., San Francisco, Calif.). Psychol. Rev., 68: 385-95(1961).

A review is given on experiments in which ionizing ra-

diation was used as a motivating stimulus to elicit avoidance behavior in animals. Saccharin-flavored water, in a concentration highly preferred to tap water by rats, was used as the conditioned stimulus. Rats drank either saccharin-flavored water or tap water in conjunction with either a sham exposure, a 30-r, or a 57-r dose of γ rays. Following a single treatment they were tested for saccharin preference (saccharin fluid vs tap water) in their home cages. Animals that drank saccharin-flavored water during actual exposure exhibited a marked aversion for the fluid during the postirradiation tests, whereas the remaining groups continued to display a high preference for the saccharin solution. The effect was dose dependent and persisted for more than 4 weeks following the 6-hr radiation exposure. A dose of 54 r elicited a decrement in postirradiation saccharin preference when the beam was directed at the abdomen. The decrement was not so pronounced as that observed following whole-body exposure with the same dose. The 54-r dose had no appreciable effect when the beam was directed towards the head, thorax, or pelvis. However, depressions in saccharin consumption were produced when the dose to these regions was raised to 252 r. Therefore, while the abdomen proved to be the most sensitive area, conditioning can be instigated by irradiation of other regions with higher doses. Radiation conditioning has a marked resistance to interference by surgery or drugs. (TCO)

24963 LENS EPITHELIAL CELL PROLIFERATION AND MIGRATION IN RADIATION CATARACTS. Calvin Hanna and James E. O'Brien (Univ. of Vermont, Burlington). Radiation Res., 19: 1-11(May 1963).

The left eyes of young and adult mice and rats were exposed to 2400 r of γ radiation from a Co^{60} source administered at the rate of 40 r/min. The right eyes of the animals served as controls. Thymidine–tritium is incorporated into the deoxyribonucleic acid (DNA) in the synthesis phase of cell division. The number of epithelial cells labeled per section of lens and the number of grains found per cell were taken as a measure of nucleic acid synthesis. The change in position of labeled cells with time was taken as an indication of cell movement. Initially, the grain count per cell decreased temporarily and then remained near the control level after irradiation. Frequency of cell labeling remained constant for several weeks and then increased moderately. The germinative zone remained in the normal pre-equatorial position even though there was considerable cell damage evident in the epithelium and cortex regions of the lens. Cells from the germinative zone in the adult rat moved slowly after irradiation. These labeled cells were not found to enter the lens cortex until after the cataract was well advanced or complete. In younger animals cell migration was fast enough so that labeled cells moved into the lens and migrated toward the posterior pole sometimes before the cataract was complete. In the mouse these labeled cells migrated toward the posterior pole just under the lens capsule to form plaques. Lens fiber damage in all cases was well advanced before cells in the zone of DNA synthesis at the time of irradiation migrated and reached the area of opacity in the lens cortex. Previous work on radiation cataract formation has been critically reviewed, and a postulated sequence of events leading to the cataract has been put forth. In this sequence of events, damage to the newly forming lens fibers at the time of irradiation is seen as directly leading to the cataract. (auth)

24964 KINETICS OF ENZYME INACTIVATION BY IONIZING RADIATION. Tore Sanner and Alexander Pihl (Norsk Hydro's Inst. for Cancer Research, Oslo). Radiation Res., 19: 12-26(May 1963).

A general kinetic analysis of enzyme inactivation in solution by ionizing radiation has been carried out. In the treatment the possibility is included that active and inactive enzyme molecules may deactivate radiation-induced radicals at different rates. The analysis has proved capable of explaining several experimental observations which were difficult to reconcile with previous treatments. The treatment reveals that, if the active enzyme molecules remove the agents formed from water more rapidly than do the radiation-inactivated ones, deviations from exponential dose-inactivation curves will occur. This may explain such deviations found in the literature. Significant deviations will ordinarily be expected only when the yield of inactivation is high. The almost linear dose-inactivation relationship previously found for papain can be adequately explained on this basis. Special circumstances are responsible for the finding that alcohol dehydrogenase from yeast and rabbit muscle glyceraldehyde-3-phosphate dehydrogenase exhibit nonexponential dose-inactivation curves, in spite of the fact that their over-all yields of inactivation are low. A procedure is given for determining experimentally the true yield of inactivation when contaminating and protective substances are present. It follows from the analysis that the presence of inactive enzyme molecules in the preparation prior to the exposure will affect the yield of inactivation only when the active and inactive enzyme molecules differ in their ability to deactivate radicals. The very high observed yield of inactivation previously found in the case of papain can in part be ascribed to the presence in the preparation of inactive enzyme molecules. For enzymes which are inactivated at low yields, the true yield of inactivation will be nearly equal to the observed yield at high enzyme concentration. (auth)

24965 X-RAY INACTIVATION OF PAPAIN IN SOLUTION. Alexander Pihl and Tore Sanner (Norsk Hydro's Inst. for Cancer Research, Oslo). Radiation Res., 19: 27-41(May 1963).

Crystalline papain was found to be the most radiosensitive enzyme so far studied. The dose inactivation was nonexponential, and for low dose rates it approached a linear function. The enzyme inactivation could be accounted for almost entirely by a radiochemical oxidation of its single essential SH group. The enzyme could be partly reactivated by cysteine addition after the exposure. The data indicate that in part intermolecular protein disulfides were formed which were rather resistant to further radiochemical oxidation. The observed ionic yield decreased strongly with increasing dose rate, and the inactivation showed a pronounced aftereffect. These effects were shown to be due to the action of radiation-induced hydrogen peroxide. In the presence of catalase the yield of inactivation was the same in air as in nitrogen ($G \approx 1.2$). Blocking of the active SH group with a cysteamine residue reduced the enzyme inactivation by x rays by factors of 8.2 and 5.5, in the absence and in the presence of catalase, respectively. (auth)

24966 THE EFFECT OF WHOLE-BODY X-IRRADIATION ON THE DISTRIBUTION OF ACID DEOXYRIBONUCLEASE AND β-GALACTOSIDASE IN SUBCELLULAR FRACTIONS OF RAT SPLEEN. Jay S. Roth and Sylvia Hilton (Univ. of Connecticut, Storrs). Radiation Res., 19: 42-9(May 1963).

The distribution of acid DNase activity in spleen subcellular fractions of rats given 700 r of whole-body x irradiation was determined 16 and 64 hours postirradiation

and compared to that in pair-fed controls. In the controls, the percentage distribution in nuclei, mitochondria, microsomes, and supernatant fraction was 25.8%, 30.6%, 10.7%, and 32.5%, respectively. Sixteen hours after irradiation this had changed to 15.9%, 26.9%, 13.1%, and 44.2% for the same fractions, respectively. There was no further significant change at 64 hours. Considerable increases in specific acid DNase activity were measured in the homogenate and all fractions 16 hours postirradiation; smaller changes were observed at 64 hours. At 16 hours postirradiation, evidence was obtained for a small net increase (14.5%) in total spleen DNase activity, compared to that in controls, and it was suggested that this increase might be caused by either increased enzyme synthesis or increased susceptibility of spleen lysosomes from irradiated animals to breakage during isolation and assay. In spleen of control animals, 67% of the β-galactosidase activity was found in the supernatant fraction, and 700 r of whole-body x irradiation did not significantly alter the distribution of this enzyme in subcellular fractions at either 16 or 64 hours postirradiation. (auth)

24967 EFFECTS OF X-RAY AND NEUTRON DOSE FRACTIONATION ON THE MOUSE TESTIS. G. Silini, S. Hornsey, and D. K. Bewley (Hammersmith Hospital, London). Radiation Res., 19: 50-63(May 1963).

Male albino mice were irradiated with single and fractionated doses of 8-Mev x rays or fast neutrons, and the radiation damage to the testes was assessed from the weight loss of the organs. An RBE of neutrons against x rays of 4.85 ± 0.31 (σ) was found at 28 days after single-dose irradiations. Splitting of the doses into two equal fractions given 4 or 7 days apart did not result in any significant change of the RBE value. (auth)

24968 THE X-RAY SENSITIVITY OF SERRATIA MARCESCENS. D. L. Dewey (Mount Vernon Hospital, Northwood, Middx, Eng.). Radiation Res., 19: 64-87 (May 1963).

Serratia marcescens was irradiated with 200-Kv and 250-Kv x rays under a number of conditions of temperature, dose rate, and pH. The log surviving fraction was plotted against dose so that the slope and hit number of the inactivation curve could be measured in every case. The effect of bubbling the bacterial suspension with the following gases was noted: oxygen, nitrogen, nitric oxide, nitrous oxide, and hydrogen. The effect of the following substances at various concentrations in solution was also noted: glycerol, ethanol, ethylene glycol, cysteine, dimethyl sulfoxide, and N-ethylmaleimide. Various conbinations of physical conditions, gases, and chemicals were investigated. In a plot of the log surviving fraction against dose, the survival curve in oxygen was found to be a straight line over many powers of 10. In nitrogen the survival curve was not straight. Three types of damage were deduced: damage observed by small doses in nitrogen, additional damage in oxygen, and a temperature-dependent post-irradiation damage observed at high doses in nitrogen. Oxygen protects against postirradiation damage. Glycerol and other alcohols protect damage in both oxygen and nitrogen. N-Ethylmaleimide sensitizes the postirradiation type of damage. Cysteine protects against damage in nitrogen and the postirradiation damage but not against damage in oxygen. (auth)

24969 EFFECTS OF DRUGS ALONE, OR COMBINED WITH REFRIGERATION, IN PROTECTING FEMALE MICE AGAINST X-IRRADIATION-INDUCED STERILITY. A. Katherine Rupkey, Ruth Gold, Roberts Rugh, and S. C. Wang (Columbia Univ., New York). Radiation Res., 19: 88-103(May 1963).

Female CF-1 mice were irradiated over the whole body surface at 25 r, 50 r, 100 r, or 150 r. These mice were pretreated with Hydergine, 0.3 mg/kg and 0.6 mg/kg; chlorpromazine, 23 mg/kg and 45 mg/kg; promethazine, 23 mg/kg and 45 mg/kg; urethan 0.6 gm/kg; reserpine, 3.3 mg/kg; various combinations of these drugs; and physiological saline solution as control. One-half of these pretreated groups were additionally cooled by refrigeration. Our results indicate that, of all types of drug pretreatment, chlorpromazine and reserpine clearly showed the most consistent radioprotective effect on fertility, especially at the level of 50 r and 100 r of x irradiation. Refrigeration appears to afford additional radioprotection. The radioprotection is evidenced by increases both in rate of fertility and in litter size during the fertile period. (auth)

24970 BONE MARROW LIPIDS IN RATS EXPOSED TO TOTAL-BODY IRRADIATION. Fred Snyder and Edgar A. Cress (Oak Ridge Inst. of Nuclear Studies, Tenn.). Radiation Res., 19: 129-41(May 1963).

Thin-layer chromatography was used to demonstrate that bone marrow lipids of rats were primarily triglycerides; gas-liquid chromatography of the fraction revealed that palmitic and oleic acids account for more than 80% of the fatty acids. Minor lipid components present in the control and irradiated marrow are glyceryl ethers, cholesterol, fatty acids, and phospholipids. Cholesterol esters were not found. Total-body irradiation (800 r) increases the femur marrow triglyceride fraction approximately six times by 1 week after irradiation, and it remains elevated for many weeks. The relationship between dose and increase in marrow triglycerides appears to fit the equation $y = bx^4$. The water and lipid content of bone marrow bear a reciprocal relation to each other, while both water and residue are significantly reduced in the irradiated femur marrow. (auth)

24971 COMPARATIVE LATE SOMATIC EFFECTS OF SOME RADIOMIMETIC AGENTS AND X-RAYS. J. W. Conklin, A. C. Upton, K. W. Christenberry, and T. P. McDonald (Oak Ridge National Lab., Tenn.). Radiation Res., 19: 156-68(May 1963).

Young adult RF female mice were subjected to midlethal doses of nitrogen mustard (HN2), triethylene melamine (TEM), and whole-body x rays, and the survivors were observed throughout the remainder of their lives for effects on longevity and on the incidence of late-occurring diseases. The life span was shortened by all treatments. The mean survival time in the various groups was as follows: x rays, 396 days; TEM, 508 days; HN2, 561 days; and controls, 638 days. The reduction in longevity was not attributable to the induction of neoplasia but was correlated with an increase in the age-specific death rate from diseases of all types. However, the increase varied in degree from one disease to another. Hence, the effects were not equivalent to premature aging in the simplest sense. TEM markedly increased the total incidence of thymic lymphomas, pulmonary adenomas, and lung tumors. HN2 markedly increased the total incidence of pulmonary adenomas and ovarian tumors. X rays markedly increased the total incidence of thymic lymphomas and ovarian tumors but reduced the total incidence of pulmonary adenomas. All agents caused premature lens opacities, but x rays alone induced changes of greater severity than those occurring spontaneously in senile controls. (auth)

24972 MUTATION AND KILLING OF ESCHERICHIA COLI WP-2 BY ACCELERATED HEAVY IONS AND OTHER RADIATIONS. R. A. Deering (Yale Univ., New Haven). Radiation Res., 19: 169-78(May 1963).

The Yale heavy ion linear accelerator and other radiation sources have been used to irradiate Escherichia coli, strain WP-2 (tryptophan-requiring). Radiations used were: 140-Mev oxygen ions, 40-Mev α-particles, 1-Mev electrons, Co^{60} γ-rays, and 250-Kvp x rays. Cell survival and reversion to tryptophan independence were studied. At doses giving common survival fractions there are about one-half as many reversions for the oxygen ions as for the other radiations. Complete curves for survival and reversion as a function of radiation dose are presented. The effect of irradiating in nitrogen versus irradiating in air has been studied for survival and reversion to tryptophan independence. For survival, the nitrogen protective effect is equivalent to a factor of about 3.5 in dose for x rays and 1.5 for oxygen ion irradiation. For reversion to tryptophan independence, this effect is about 1.7 for x rays and 1.3 for oxygen ion irradiation. (auth)

24973 IMPLICATIONS OF ORGANIC PEROXIDES IN RADIOBIOLOGY. Proceedings of an International Symposium, Argonne National Laboratory, Argonne, Illinois, May 7-9, 1962. Robert N. Feinstein, Co-ed. Radiation Res., Suppl. 3, 1-317(1963).

Separate abstracts were prepared on 18 papers presented at this symposium. One paper was previously abstracted and appeared in NSA. (C.H.)

24974 CHEMISTRY OF THE ORGANIC PEROXIDES. Cheves Walling (Columbia Univ., New York). Radiation Res., Suppl. 3, 3-16(1963).

It is generally accepted that the major initial steps on irradiation of biological systems involve the radiolysis of water to produce H·, HO·, and H_2O_2; the attack of H· and HO· on organic molecules to yield organic radicals; direct radiolysis of organic molecules to produce radicals (and molecules in excited states); and reaction of organic radicals with oxygen to yield peroxy radicals (and subsequently organic peroxides). However, from the outline of peroxide chemistry given, it is evident that many additional processes must be considered. Organic peroxides may also be formed by reaction of oxygen with molecules in excited states, and by reactions of organic molecules (perhaps enzyme-catalyzed) with hydrogen peroxide. The resulting organic peroxides can undergo a whole series of nonradical reactions (perhaps subject to enzyme catalysis) including S_N2 displacements on oxygen, electron-deficient rearrangements, β-eliminations, and a variety of cyclic processes. The peroxides may also undergo decomposition into radicals by several paths, of which the most important under biological conditions are oxidation-reduction reactions with organic substrates or transition metal ions (perhaps both enzymatic processes) and reactions involving energy transfer from excited states. The complex reactions of these resulting radicals must also be accounted for. This imposing variety of reactions potentially available suggests that it will be some time before the detailed role of peroxides in radiation chemistry will be clearly understood. (auth)

24975 BIOCHEMICAL IMPLICATIONS OF PRO-OXIDANTS AND ANTIOXIDANTS. Frederick Bernheim (Duke Univ., Durham, N. C.). Radiation Res., Suppl. 3, 17-32(1963).

Lipid peroxides can be detected in intact adipose tissue cells but have not been shown to be present in other normal cells. On injury of such cells, they are rapidly formed. This post-injury formation is dependent on traces of inorganic iron liberated from a protein- or hematin-bound state. Ascorbic acid acts as a co-oxidant in the reaction. The iron-catalyzed reaction can be inhibited by the addition of chelating agents, including free fatty acids, or by antioxidants such as vitamin E added in vitro. Adding excess vitamin E to the diet also decreases lipid peroxidation in the injured cells. Tissues in which cell division is continuously occurring (bone marrow, tumors, intestinal mucosa) produce no lipid peroxides even after the cells are injured. Antioxidant activity in these cells must be exceptionally high. Analysis of the conditions in intestinal mucosa shows that phospholipase activity can be correlated with antioxidant activity. After irradiation, the virtual absence of a cofactor reduces the phospholipase activity and reduces the antioxidant to the same extent. The nature of the antioxidant in bone marrow and tumor is still unknown. (auth)

24976 ADDENDUM: MECHANISMS OF LIPID PEROXIDE FORMATION IN RAT TISSUE HOMOGENATES. Albert A. Barber (Univ. of California, Los Angeles). Radiation Res., Suppl. 3, 33-43(1963).

Results are reported from studies of factors involved in the production of peroxides in certain tissues, such as brain and liver, and factors in those tissues that do not produce peroxides that make them different from the peroxide-forming group. It was concluded that a complex of inhibitors is available in tissues, and that these inhibitors normally are present in the whole tissue homogenate, as well as in the whole intact tissue. However, it appears that homogenization and dilution break down a certain number of these. These inhibitors might include such things as the breakdown of the normal iron binding in tissues. In some tissues a sufficient amount of this antioxidant complex is broken down to allow for peroxidation to occur in aerobically incubated homogenates. Such tissues include the brain, liver, and kidney. In certain other tissues, a reserve of antioxidant material presumably is left, such as that in the protein fraction, which will inhibit peroxidation. This appears to be the case for testis and intestinal mucosa. (auth)

24977 THE ROLE OF PRO-OXIDANTS AND ANTI-OXIDANTS IN OXYGEN TOXICITY. Daniel L. Gilbert (Jefferson Medical Coll., Philadelphia). Radiation Res., Suppl. 3, 44-53(1963).

Various biological antioxidant mechanisms which protect organisms against the toxic effects of oxygen are discussed. Interference with such mechanisms produces a pro-oxidant effect, and enhancement of such mechanisms produces an antioxidant effect. Free radicals can catalyze the inherent oxidations within organisms. Decreasing the free-radical concentration is an antioxidant effect, and increasing the free-radical concentration is a pro-oxidant effect. It is possible that a chemical can possess both pro-oxidant and antioxidant properties. Depending on the biological system and on the criterion for judging oxidation, the net prevailing influence of such a substance may be either pro-oxidant or antioxidant. (auth)

24978 THE ESTIMATION AND IDENTIFICATION OF ORGANIC PEROXIDES. J. St. L. Philpot (Medical Research Council, Harwell, Berks, Eng.). Radiation Res., Suppl. 3, 55-70(1963).

The analytical label pro-blue is proposed instead of peroxide for substances able to oxidize anoxic leuco Brilliant Cresyl Blue. The label pro-red is proposed for substances

giving a red color with thiobarbituric acid. Experiments are described, aimed at correlating observations on pro-blue and pro-red in irradiated animals. It is concluded that irradiation of an animal produces an oxidant, which may be a peroxide or a result of oxidation by a peroxide or an independent product, and that it also produces a deficiency of antioxidant which may be related as either cause or effect, or both, to the production of oxidant. (auth)

24979 DETECTION, SEPARATION, AND IDENTIFICATION OF ORGANIC PEROXIDES. Nicholas A. Milas, Robert S. Harris, and Aleksandar Golubovic (Massachusetts Inst. of Tech., Cambridge). Radiation Res., Suppl. 3, 71-92 (1963).

In spite of our highly sensitive chromatographic methods for the detection of organic peroxides, we have been unable to detect significant amounts of these peroxides, in the tissues of rats and chicks fed α-tocopherol-deficient or vitamin A-deficient diets, or fed oxidized oils containing peroxides, or subjected to high doses of x radiation. Therefore, it is reasonable to conclude that whatever peroxides are formed in living tissues are too highly unstable to survive separation from these tissues, provided adequate techniques are employed to avoid oxidation during separation. If significant amounts of peroxides are formed in living tissues, we must devise methods for their detection in vivo. (auth)

24980 CATALASE, HYDROGEN PEROXIDE, AND IONIZING RADIATION. Howard I. Adler (Oak Ridge National Lab., Tenn.). Radiation Res., Suppl. 3, 110-29 (1963).

There are many references in the literature to the involvement of hydrogen peroxide in radiobiological phenomena. The extent to which this compound is involved depends, in part, on the catalase activity of the organism being studied. We have accumulated data on hydrogen peroxide and ionizing radiation inactivation of bacterial cells with no catalase activity, with intermediate catalase activity, and with very high catalase activity. Radiation-produced hydrogen peroxide is responsible for a postirradiation inactivation observed in a catalase-negative Escherichia coli strain. The addition of catalase prevents this postirradiation inactivation but is without effect on the prompt inactivation except if the cells have been grown in a glucose-rich medium. Experiments with three catalase-positive E. coli strains show that there is no positive correlation between catalase content and radiation resistance. There is, however, a correlation between resistance to ionizing radiation and to reagent hydrogen peroxide in these strains. Experiments with a high-catalase mutant of the bacterium Rhodopseudomonas spheroides indicate that, in this organism, catalase is not a significant radiation-protective agent. The results with these bacterial strains of different catalase activities are discussed in relation to other reports, and an attempt is made to define some of the factors that affect the relations between catalase, hydrogen peroxide, and ionizing radiation. (auth)

24981 DETECTION AND FIXATION OF RADIATION-PRODUCED PEROXIDE BY ENZYMES. Hugo E. Aebi (Universität, Bern). Radiation Res., Suppl. 3, 130-52 (1963).

Evidence is presented that enzymes can be used as a tool for the detection and fixation of radiation-produced peroxide. Three procedures are described, each of which offers some advantages, but none of which is ideal.

24982 DETECTION OF RADIATION PRODUCTS. Bernard Smaller (Argonne National Lab., Ill.). Radiation Res., Suppl. 3, 153-70(1963). (TID-16881; UAC-6663)

The elementary principles of electron paramagnetic resonance are reviewed and data are reevaluated in the light of more recent experiments. Emphasis is placed on the magnetic parameters derived from the experimental results that are used to describe free radicals induced by radiation in biological systems. Topics discussed include applications of EPR techniques in identification of the radiolysis products of water, in studies of free radicals formed from γ irradiation of biochemicals, in studies in irradiated biological systems, in studies of irradiated single crystals, in the detection of triplet states in crystals, and in studies on the role of oxygen in modifying the EPR spectrum. (C.H.)

24983 PEROXIDES AND THE INDUCTION OF MUTATIONS BY X-RAYS, ULTRAVIOLET, AND FORMALDEHYDE. F. H. Sobels (RIJKS universiteit, Leiden). Radiation Res., Suppl. 3, 171-83(1963).

Results are reviewed from studies on the role of peroxides in the induction of mutations in Drosophila by x rays, ultraviolet radiation, and formaldehyde. It is concluded that the formation of either an organic peroxide or of free radicals, including peroxidic and peracid radicals, are involved in the production of mutations by formaldehyde and also perhaps in the radiosensitizing effect exerted by formaldehyde. No experimental evidence was found for a direct effect of peroxides in the production of mutations by x irradiation in Drosophila. (C.H.)

24984 PEROXIDES AND MUTATIONS. Orville Wyss, Carl Wiesen, and George E. Schalberger (Univ. of Texas, Austin). Radiation Res., Suppl. 3, 184-91(1963).

The role of peroxides, produced by radiation or oxidative processes in metabolism, in the production of mutations is reviewed. Results are reported from studies on living cells immersed in peroxides modified in various ways. Results are used to postulate the action of internally formed peroxides on the hereditary substance. It is concluded that it will be difficult to assess the role of peroxide in the mutational process until further information is available on the chemistry of the various parts of the microbial cell. (C.H.)

24985 ORGANIC PEROXIDES, HYDROGEN PEROXIDE, EPOXIDES, AND NEOPLASIA. Paul Kotin and Hans L. Falk (Univ. of Southern California, Los Angeles). Radiation Res., Suppl. 3, 193-211(1963).

Preliminary data are reported that support the suspicion that organic peroxides may possess carcinogenic properties. This suspicion in large measure relates to the acknowledged mutagenicity of certain peroxides. As a possible mechanism of action it is suggested that peroxides may act by catalyzing the depolymerization of deoxyribonucleic (DNA) and ribonucleic acid (RNA). This radiomimetic property may provide a fundamental bridge between the carcinogenicity of ionizing radiation and that of organic peroxides when used in pure form. Emphasis has also been directed to the carcinogenic properties of epoxides. Organic peroxides may lead to the formation of epoxides, and the established carcinogenicity of epoxides has resulted in the accumulation of a large body of information relating to the mechanism of their action. Of particular significance in this area is their capability of acting as crosslinking agents. The possibility of utilizing the established carcinolytic properties of certain carcinogenic agents in the study of the carcinogenic properties of organic peroxides is discussed. (auth)

24986 HYDROGEN PEROXIDE, CATALASE, GLUTATHIONE PEROXIDASE, QUINONES, NORDIHYDROGUAIARETIC ACID, AND PHOSPHOPYRIDINE NUCLEOTIDES

IN RELATION TO X-RAY ACTION ON CANCER CELLS. Dean Burk and Mark Woods (National Cancer Inst., Bethesda, Md.). Radiation Res., Suppl. 3, 212-46(1963).

Data are reviewed on the relationship between hydrogen peroxide and x radiation effects in formed cancer cells. Topics discussed include the interrelationships between hydrogen peroxide, catalase, glutathione, peroxidase, quinones, nordihydroguaiaretic acid, and phosphopyridine nucleotides in relation to metabolism in irradiated cancer cells. The metabolic sites of action of chemotherapeutic agents and metabolic and biochemical mechanisms involved in the action of x radiation are considered. (C.H.)

24987 PEROXIDATION OF NUCLEIC ACIDS BY RADIATION: BIOLOGICAL IMPLICATIONS. R. Latarjet, B. Ekert, and P. Demerseman (Institut du Radium, Paris). Radiation Res., Suppl. 3, 247-56(1963).

Radioperoxidation is an efficient process on nucleic acids in aerated water solution. At the level of the pyrimidines, it accounts for the bulk of the reaction induced by ionizing radiation. In the absence of oxygen, the yield of the overall reaction is decreased by a factor of 3. Peroxidation does not take place; the final main product is glycol. Peroxidation is prevented by mercaptoethylamine, which acts at the level of the first two steps of the reaction. This protector acts as an antioxygen in so far as the mechanisms which it puts into play counteract those which depend on the presence of oxygen. Indirect peroxidation by peroxides formed by radiation in the vicinity of DNA is a possible event. It depends highly on the presence of trace metal catalysts. It may yield the same final compounds as direct peroxidation. These alterations can play a role as primary lesions in some radiobiological processes. (auth)

24988 THE RADIATION SENSITIVITY OF DEOXYRIBONUCLEIC ACID. W. R. Guild (Duke Univ., Durham, N. C.). Radiation Res., Suppl. 3, 257-69(1963).

The number of ionizing events which occur in DNA per mean killing dose (D_{37}) varies from 1 in the simplest viruses and cells to several hundred in mammalian cells and even more in plant cells. Indirect action adds significantly to the number of attacks on the DNA. Analysis of the probability of damage per initial hit leads to the conclusion that each one produces permanent chemical alteration of the DNA, and that biological transforming activity is destroyed also, with an efficiency at least 0.2 and more probably 1.0. Most of this damage appears to be at the level of genetic recombination in the transforming system. There is therefore a large amount of damage to DNA at typical killing or mutating doses, and any mechanism for radiation action must account for why more damage does not appear at lower doses. Extensive cellular repair of the reparable portion of the damage provides a model which accounts for many features of observed radiation biology. (auth)

24989 PEROXIDES IN RADIOBIOLOGY: A SYNTHESIS. Radiation Res., Suppl. 3, 270-304(1963).

The role of peroxides in radiobiology is reviewed. Topics discussed include the chemistry and physics of radicals, their formation, recognition, and reactivities, with emphasis on radioinduced free radicals in biological systems. (C.H.)

24990 ALTERATIONS OF THE MICROSCOPIC STRUCTURES OF THE HUMAN INTESTINAL MUCOSA IRRADIATED BY MEANS OF SMALL DOSES OF X-RAYS. G. Tori and G. Gasbarrini (Università, Bologna). Radiol. Clin., 32: 47-56(1963). (In English)

Studies carried out on phenomena occurring at the molecular level in human intestinal mucosa after administration of small doses of x rays are reported. Biopsies carried out by means of Crosby's sound in a series of 10 women with neoplasm of the uterine cervix were studied by the electron microscope. To date, the results pertain only to epithelial cells lining the villi. Although after administration of 50 rads no alterations were found in the ultramicroscopic structures, after 100 rads alterations were noticed in the cytoplasm of large-sized granules showing dishomogeneous structures, a finding that is not seen in the normal mucosa. Alterations in size and shape were also noted in the microvilli. The hypothesis that the granular formations observed might represent different metabolic conditions in the structures that make up the enzymic patrimony of the cells is tentatively submitted. (P.C.H.)

24991 OUR EXPERIENCE WITH COBALT BEAM UNIT GUT-Co-400-2. L. Brueckner, J. Černý, and F. Beška (Oncological Dept. of KNSP, Ostrava, Czechoslovakia). Radiol. Clin., 32: 142-51(1963). (In English)

On the basis of experience gained with the irradiation of 169 patients by the Co beam unit GUT-Co-400-2 over a period of 20 months, the early therapeutic results obtained, both curative and palliative are demonstrated. Special attention is given to post-radiation alterations, particularly on the skin, and at the same time reactions both in patients irradiated only by a Co beam unit and in those irradiated by a Co beam unit after previous x-ray or Ra therapy are evaluated. (P.C.H.)

24992 SCHISTOSOMA MANSONI: DEVELOPMENT OF CHALLENGE INFECTIONS IN MICE EXPOSED TO IRRADIATED CERCARIAE. Alina Perlawagora Szumlewicz (Instituto Nacional de Endemias, Rurais Belo Horizonte, Brazil) and Louis J. Oliver. Science, 140: 411-12(Apr. 26, 1963).

The principal effect of x-irradiated Schistosoma mansoni cercariae may be to slow the migration and development of the worms of a challenge infection. This would account for the smaller number of worms found in the portal system in the early weeks and the delayed accumulation of recoverable worms and eggs. (auth)

24993 HOMOGRAFT TOLERANCE IN MICE: USE OF URETHAN AND SUBLETHAL IRRADIATION. W. E. Davis, Jr. and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Science, 140: 483-4(May 3, 1963).

Adult mice [CBA/J ($H\text{-}2^k$)], which received either a single sublethal dose of x radiation (500 rad) or urethan plus 500 rad, were given intravenous injections of C3H/HeJ ($H\text{-}2^k$) spleen or bone marrow cells (18 to 42×10^6 cells per mouse) or both, for 3 days. C3H/HeJ tail-skin homografts were retained (over 130 days) by the mice, whereas BALB/cJ ($H\text{-}2^d$) homografts all were rejected within 33 days. Similarly irradiated or urethan-treated controls (or controls treated with a combination of both), which did not receive C3H cells, rejected both homografts. Specific homograft tolerance was induced in adult mice by the procedure. (auth)

24994 X-RAY SENSITIVITY AND DNA SYNTHESIS IN SYNCHRONOUS POPULATIONS OF HeLa CELLS. Toyozo Terasima and L. J. Tolmach (Washington Univ., St. Louis). Science, 140: 490-2(May 3, 1963).

Inhibition with either 5-fluorodeoxyuridine or deoxyadenosine for specified periods during the division cycle of the HeLa S3 cell shows that the mid-interphase peak in sensitivity occurs just before DNA replication begins. Sensitivity subsequently decreases only after synthesis of DNA is resumed. One interpretation of the relation be-

tween fluctuations in sensitivity and in DNA synthesis is that the lethal radiation damage to the cells occurs in DNA. (auth)

24995 EFFECT OF TOTAL IONIZING IRRADIATION ON THE PLASMOLOGEN CONTENT OF THE BRAIN. M. N. Baryshnikova (Kirov Medical Inst., Gor'ku, USSR). Ukr. Biokhim. Zh., 35: 99-103(1963). (In Russian)

The effect of ionizing radiation on the quantitative content of plasmologens was studied. Sexually mature albino rats were subjected to a single whole-body irradiation of 1000 r. The irradiated rats were taken for experiment after three days. The quantitative estimate of the plasmogens was carried out by a calibrating curve of palmitic aldehyde, which was synthesized beforehand. It was found that in all cases x ray induced an increase in the quantity of plasmologens in the brain. In normal albino rats there was 10.4 ± 0.35 mg/g of brain. Hence, with a dose of 1000 r the quantity of plasmogen increased by about 20 to 30% as compared with the normal. The plasmogen content of the brain changes with the season. During the spring-summer period it is considerably higher than in winter. However, the season does not affect the relative change in the quantity of plasmologens during irradiation. (P.C.H.)

24996 THE ACTION OF THE RADIOACTIVE PHOSPHORUS ISOTOPE P^{32} ON BARLEY UNDER VARIOUS CONDITIONS OF GERMINATION. W. Hentrich (Institut fuer Pflanzenzuechtung, Dornburg/Saale, Ger.). Z. Pflanzenzuecht., 46: 417-32(Dec. 1961).

Various factors were investigated in seeds germinated by soaking in solutions containing P^{32}. A fundamental difference in the degree of effectiveness of P^{32} was found between seeds kept in germinated condition at a temperature of 0 to 2°C, and those that, after soaking in P^{32} solution, were redried. In contrast to the redried seeds, the factors that decrease the speed of germination of moist germinating seeds increase the damaging effect of P^{32}. As P^{32} is chiefly conducted into meristematic tissue where the cells are dividing, the number of cells in which the available quantity of P^{32} is concentrated is small when germination is proceeding slowly; however, their load of P^{32} is high. Also, P^{32} is only incorporated in growing constituents (DNA) so that the radiation received in such constituents is high. After redrying the seeds, irrespective of the time of sowing, seedlings were damaged by doses of 3 μC P^{32} or more per grain. Germinating seeds for which sowing was delayed 50 to 70 days showed definite growth disturbances with 0.25 μC P^{32} per grain. By giving a liberal nutrient supply, especially of inactive phosphorus, the effect of P^{32} could be reduced slightly. (TCO)

24997 CHANGES IN QUANTITATIVE TRAITS UNDER SELECTION AND IRRADIATION. Alan Claymore Barlett. Thesis, Lafayette, Ind., Purdue Univ., 1962. 206p.

Early in the history of a highly heterozygous population of Tribolium castaneum Herbst, artificial selection for increased body weight was imposed on individuals and families. The selected lines showed rapid response to high selection and the average body weight increased far beyond the range of phenotypic expression in the original population. A point was reached in the work with these selected populations where further response to high selection was not obtained. The nature of the factors causing this plateau to high selection was investigated as part of the present study. Reproductive and developmental difficulties were shown to be the limiting factors in response to high selection. Since the original foundation strain, from which the large strains originated, still existed, an experiment was designed to compare strain response of body weight to high selection and random selection along with response to three levels of irradiation: 0, 100 r, and 1000 r. Reproductive fitness was also measured in terms of the number of progeny per mating in a treatment combination. In the foundation strain, which had previously been only random mated, high selection alone was efficient in altering body weight. Irradiation alone significantly decreased progeny number, but irradiation applied in conjunction with high selection had a detrimental effect on both response to high selection and upon progeny number. In the large strain, high selection was still the most efficient method of changing body weight. Irradiation plus high selection caused progeny number to decline, and body weight did not respond as rapidly to high selection as was shown for high selection alone. (Dissertation Abstr.)

24998 PENETRATION AND ABSORPTION OF IONIZING RADIATIONS IN SKIN. Carl F. Tessmer (Walter Reed Army Medical Center, Washington, D. C.). p.393-406 of "First International Conference on the Biology of Cutaneous Cancer, Philadelphia, Penna., Apr. 6-11, 1962." Frederick Urbach, ed. National Cancer Inst. Monograph No. 10. Washington, D. C., Government Printing Office, 1963.

From a survey of the physical aspects of various kinds of radiation and the morphologic changes it produces, it was concluded that the penetration and absorption of ionizing radiation in the skin leads to generally predictable effects, including destructive effects, which can be roughly quantitated, but subject to biologic and physical variations. Current concepts provide that all forms of ionizing radiation have a similar end result for equivalent energy transfer. Animal data are extremely useful, and comparable in certain limited aspects, including probably that of carcinogenesis, but are not directly translatable to man. Minor species differences may also be noted. (TCO)

24999 COMPARISON OF THE EFFECT OF FRACTIONATION OF X-RAYS AND FAST ELECTRONS. G. Reitz. Thesis, Giessen, Ger., Universität, 1962. 35p. $2.00.

The general aspects of dose fractionation with fast electrons are discussed. The tails of 160 rats were irradiated with x rays and $Sr^{90}-Y^{90}$ β rays. The development of erythema after single and fractionated irradiation was observed. The results indicate that decrease of skin reaction by dose fractionation is more pronounced for β rays than for x rays. A time delay for the production of necroses was observed. These results are in agreement with the measurements of Yannakopoulos and Jacobson. The possibilities for application of fractionation in therapy are discussed. (Gmelin Inst.)

25000 THE INFLUENCE OF IONIZING RADIATIONS ON THE PERIPHERAL FROG NERVE. A. R. Both. Thesis, Bonn, Universität, 1962. 58p. $2.00.

The effect of x rays on the action current curve of frog ischiadicus is studied in the temperature range between 20 and 40°C. Stimulation frequency was 50 per sec. For some of the experiments no stimulation was applied during irradiation. If a nerve is stimulated continuously the action current amplitude shows in the first time a decrease, then an increase, and finally again a decrease. Irradiation with 80 to 90 kr results in a broadening of the action current curve by approximately 20 per cent. Changes of the amplitude were not observed below 150 kr. The effect of x irradiation is smaller if no stimulation is applied during irradiation. (Gmelin Inst.)

25001 SYSTEMATIC STUDIES OF RADIATION EXPOSURE OF PATIENTS DURING THERAPEUTICAL TREATMENT WITH CONVENTIONAL AND ULTRAHARD X-RAYS. D. Schoen. Thesis, Tuebingen, Ger., Universität, 1961. 214p. $2.00.

Measurements were made of the total radiation exposure of patients during therapeutical treatment with 220 kv x rays and with 15.8 Mev x rays from a betatron. The volume dose was determined for various geometrical configurations. The dose distributions in phantoms were measured. Methods for the measurement of volume dose are reviewed. (Gmelin Inst.)

25002 STUDIES ON THE DEVELOPMENT OF IRRADIATED NIPPOSTRONGYLUS BRASILIENSIS LARVAE AND THE IMMUNOGENIC EFFECT PRODUCED IN RATS. Willie Ashley, Jr. Thesis, Washington, D. C., Catholic Univ. of America, 1962. 30p.

Groups of laboratory rats were subcutaneously inoculated with the infective stage larvae of the rate nematode, Nippostrongylus brasiliensis, irradiated with Co^{60} at dose levels of 10,000, 20,000, 30,000, 40,000, 50,000, 60,000, 80,000, 100,000, and 115,000r to study the effect of ionizing radiation on larval growth and development, and the degree of immunity produced by rats when inoculated with larvae irradiated at various dose levels and subsequently challenged with normal larvae. Data obtained from four experiments revealed that: there was a marked decrease in the growth rate of the larvae, egg production of the adult worms, and the worm burden in rats as the graded doses of radiation administered to the larvae were increased from 10,000 to 100,000r, when rats were inoculated with larvae irradiated with 115,000r, the larvae that survived had not developed in size when recovered from rats 9 days later, larvae exposed to radiation doses up to 50,000r showed no apparent alterations of their internal structures upon necropsy 10 days after inoculation, and rats inoculated with larvae irradiated at various dose levels were as effective as normal larvae in stimulating resistance to reinfection. (Dissertation Abstr. 23: May 1963)

25003 HEMATOLOGICAL STUDIES OF THE BURRO EXPOSED TO COBALT-60 IRRADIATION TO THE REGION OF THE HEAD. Ronald Eugene Engel. Thesis, Minneapolis, Univ. of Minnesota, 1962. 163p.

Twenty-two burros were paired for neurological and hematological studies. Blood collections were divided into four periods: daily from 6 to 3 days before irradiation; pre-sham-irradiation; sham-irradiation and; irradiation. Detailed peripheral blood cell morphology studies were done on smears stained with modified Wright's stain. Three cycle moving averages of the absolute values of each cell group were graphed for individual animals. A composite graph was made for each group of burros using actual data values. Seven burros received 600r and four burros 200r of gamma rays from a bilateral Co^{60} source to the region of the brain. Each burro had a paired control that was sham-irradiated. The principal target was the brain. Six out of seven burros receiving 600r died in the terminal phase of the hyperacute radiation syndrome. The animals that received 200r exhibited a few transient abnormal neurological signs. Primary leukocytosis, neutrophilia, and lymphocytosis were observed in the 600 and 200r irradiated and control groups within $1\frac{1}{2}$ hours after sham-irradiation and irradiation. Primary was used to denote the initial rise or decrease in blood values. These hematalogical reactions were considered to be the result of increased epinephrine release and physical exertion. A secondary leukocytosis and neutrophilia were observed in the burros receiving 600r. The increase of cells to a maximal value was observed within $12\frac{1}{2}$ hours post-irradiation. A primary lymphopenia was observed in all groups irradiated or not. The medium and small lymphocyte values dropped to just below the normal limits by $3\frac{1}{2}$ hours post-irradiation. The secondary lymphopenia, which reached a minimal value by $16\frac{1}{2}$ hours post-irradiation was observed only in the burros receiving 600r. Both direct lymphocytic damage and radiation-induced non-specific stress, which was mediated through the pituitary-adrenal axis, were believed responsible for the occurrence of the secondary lymphopenia in burros irradiated with large doses of Co^{60} gamma rays. A very pronounced eosinopenia was observed $12\frac{1}{2}$ hours post-irradiation in the 600r irradiated group. This persisted until death or recovery of the animal. The remaining three groups failed to exhibit any alterations in eosinophil values during a similar period. No radiation-induced erythrocyte, hematocrit, or hemoglobin alterations were observed in the irradiated or control groups during a six week observation period. The acute hematological changes observed in the 600r irradiated burros were in close agreement with early acute blood changes observed in whole body irradiation of burros and other mammalian species. The early hematological studies were valuable prognostic aids for determining the degree of radiation damage to the region of the brain of the burro. (Dissertation Abstr. 23: May 1963)

25004 CYTOGENETIC STUDIES OF GAMMA IRRADIATED RICE VARIETIES. Narayanan Madhavan Nayar. Thesis, Baton Rouge, La., Louisiana State Univ., 1962. 124p.

Dormant seeds of 3 rice varieties, Colusa (japonica), Nato (indica-japonica hybrid), and Rexoro (indica), were exposed to 9 gamma radiation treatments: 20,000, 30,000, 40,000, and 50,000r at 605r/min; 37,100r at 605r/min in 2 equal fractions; 20,480, 37,100, 41,000, and 49,500r at 2.9r/min. R_1 and R_2 generation plants from these treatments were studied in 1959 and 1960. Part of the seeds were sown shortly after irradiation and the remainder 1 year later. Effects of irradiation treatments on germination, seedling survival, seedling height, translocation frequency in PMCs, and chlorophyll mutations were studied. The fractionated treatment did not produce any appreciably different effect from that of the comparable continuous treatment. No marked differences in varietal response to different irradiation treatments were noticeable for survival and height. Translocation frequency was slightly lower in Rexoro than in the other varieties. Germination was normal in all of the treatments. Survival appeared normal in all dosages at 605r/min. There was no intensity effect on survival at the 20,000r dose level. With doses approximating 40,000r, a slight reduction was noted for the low intensity. With doses approximating 50,000r, intensity effect was very distinct, with the low intensity treatment showing only 7% survival. Seedling height was progressively reduced with increasing dosages. About 41% of all panicles examined contained 1 or more translocations. Panicles with single hexavalents occurred in greater frequencies than expected, compared to their number with 2 quadrivalents, suggesting a strong tendency for 1 chromosome pair to undergo 2 breaks. Translocation frequency increased with increasing doses up to 40,000r, and then seemed to level off. No chlorophyll mutations were obtained in the R_1 generation. In the R_2 generation, 4 types were recognized, albino, xantha, viridis, and variegated. Of these, the variegated types were often variable in appearance and expression. The 225 R_2 progenies tested

gave 42 mutations in 38 progenies, comprised of 21 albino, 6 xantha, and 15 viridis types. Mutation rate increased with increasing dosages. Irradiation by itself did not seem to affect germination and translocation frequency markedly after post-irradiation storage. But it reduced seedling survival at high dosages and low intensities. While irradiation without storage did not affect survival in any of the 605r/min treatments, there was a marked decline with the 50,000r dose following storage. Low intensity irradiation with approximately 20,000r, did not have any different effect on survival after storage than before storage. Following storage, approximately 40,000r, low intensity irradiation caused a severe reduction in survival compared to the same high intensity treatment. (Dissertation Abstr. 23: May 1963)

25005 RADIATION-INDUCED CHROMOSOME ABERRATIONS. Report of a Conference held in San Juan, Puerto Rico, November 16-18, 1961. Sheldon Wolff, ed. New York, Columbia University Press, 1963. 313p. $7.50.

Eleven papers presented at the conference and detailed reports of the discussion of each are included. A separate abstract was prepared for each paper. (A.G.W.)

25006 CHROMOSOME ABERRATIONS AND TARGET THEORY. H. J. Evans (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.8-40 of "Radiation-Induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Results of experiments on radiation-induced chromosome aberrations in Tradescantia and conclusions drawn from the results are reviewed. The following points are discussed by participants of the conference: theoretical kinetics for two-break chromosome exchanges, the nature and frequency of gaps observed in chromatids, and structure of chromosomes. (A.G.W.)

25007 CHROMATID ABERRATIONS—THE GENERALIZED THEORY. S. H. Revell (Royal Cancer Hospital, London). p.41-72 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

A previously published exchange theory for interpretation of radiation-induced chromatid aberrations at metaphase is presented briefly. In this theory all aberrations are interpreted as chromatid exchanges. It is assumed that aberrations previously interpreted as chromatid breaks and as isochromatid breaks actually arise from small intrachanges that unravel before metaphase is reached. Implications of the theory are discussed at length by participants in the conference. (A.G.W.)

25008 NUMBERS OF NUCLEAR SITES FOR ABERRATION FORMATION AND THE DISTRIBUTION OF ABERRATIONS. K. C. Atwood (Univ. of Illinois, Urbana). p.73-86 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Examples of data are shown that led to the conclusion that there must be a limited number of sites at which exchanges can occur in chromosomes. The model offered in explanation of the data has the following features: (1) An interchange cannot occur unless the points of interchange are very close together. (2) Points on different chromosome arms are seldom close enough together to permit an interchange. (3) In the time interval between irradiation and the establishment of interchanges, adjacent points on proximal and distal fragments usually remain very close together. Some limitations on the number and distribution of pre-existing proximity sites that would result in the observed distributions of interchanges are stated. Methods of estimating the rejoining distance h and the possibility that h may vary with cellular conditions are discussed. (A.G.W.)

25009 SURVEY OF WORK ON CHEMICAL BONDS INVOLVED IN ABERRATIONS. C. P. Swanson (Johns Hopkins Univ., Baltimore). p.90-9 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Studies relating to the chemistry of the larger chromosomes are surveyed. The following are discussed briefly: enzyme work relating to the digestion of chromosomes; effects of Ca and Mg deficiencies on x-ray sensitivity and spontaneous fragmentation of chromosomes; evidence that the rejoining process must be accompanied by a synthesis of proteins; effects of radiation on calf-thymus DNA protein; effects of ultraviolet radiation on chromosomes; patterns of action of chemical mutagens on chromosomes; chromosome aberrations caused by viruses; cytochemical methods for demonstrating chemical and physical changes in DNA or protein after irradiation. (A.G.W.)

25010 ABERRATIONS INDUCED BY RADIOMIMETIC COMPOUNDS AND THEIR RELATIONS TO RADIATION-INDUCED ABERRATIONS. B. A. Kihlman (Uppsala Univ.). p.100-22 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Data are presented on distribution of aberrations within and between nuclei of chromosomes after treatment with radiomimetic chemicals. In general distribution is markedly nonrandom. After treatment with most radiomimetic chemicals, no cells with aberrations appear until about 8 hr after the treatment, and peak frequency is usually 18-36 hr after treatment. In contrast aberrations begin to appear in about 2 hr after irradiation with ionizing radiations. Oxygen was found to influence the effects of several radiomimetic chemicals. Possible mechanisms of actions of the chemicals are considered. Results of other investigators are also discussed among conference participants. (A.G.W.)

25011 RADIOISOTOPE STUDIES ON THE STRUCTURE OF THE CHROMOSOME. J. H. Taylor (Columbia Univ., New York). p.123-64 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Results of radioisotope studies since 1956 are reviewed, which lead to the conclusion that a chromosome is essentially a single DNA double helix folded together in some manner. Studies of the effect of fluorouracil deoxyriboside (FUDR) on chromosomes are discussed. FUDR produces lesions that are apparently cured by later addition of thymidine. The effect is interpreted as interference with DNA replication. Studies of the effect of FUDR on radiation-induced lesions are reported briefly. The general mechanism of breakage and reunion is considered, and a scheme for reunion of broken chromatids is proposed. Some electron-microscope evidence relating to chromosome structure is presented. A model is suggested, which depicts a G2 chromosome consisting of two chromatids as two end-to-end chains of microfibrils with their couplings aligned in parallel along the axis. (A.G.W.)

25012 CHROMOSOME ABERRATIONS AND FREE RADICALS. A. D. Conger (Univ. of Florida, Gainesville). p.167-202 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Studies of free radicals induced by radiation in both pure compounds (proteins and nucleic acids) and complex bio-

logical systems are reviewed. Effects of water and oxygen are emphasized. The radiation chemistry of water and its relation to results obtained in wet biological systems are discussed. Experiments on the effects of irradiation on barley seeds are described, with particular attention to the relationship between seedling height and chromosomal damage. (A.G.W.)

25013 EFFECTS OF COMBINED UV AND X RADIATIONS ON CHROMOSOME BREAKAGE IN TRADESCANTIA POLLEN. J. S. Kirby-Smith (Oak Ridge National Lab., Tenn.). p.203-14 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Results of experiments on effects of combined x and uv radiations on chromosomes indicate a definite synergistic effect on the action of these agents regardless of whether the uv is delivered as a pretreatment or a post-treatment. The magnitude of this effect is sensitive to time interval between treatments and to exposure of pollen to high humidity or solar radiation prior to treatment. The hypothesis that uv results in the inactivation or inhibition of chromosome-rejoining mechanisms is currently favored. Exploratory studies of the effects of pretreatment with visible and near-visible radiation on sensitivity of pollen to uv alone are reported briefly. (A.G.W.)

25014 DOSE RELATIONS IN THE INDUCTION OF HUMAN CHROMOSOME ABERRATIONS. E. H. J. Chu (Oak Ridge National Lab., Tenn.). p.217-36 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Experimental studies to date on radiation-induced human chromosome breakages are summarized. The types of aberrations, the spontaneous and induced rates, the radiosensitivity of human chromosomes, and other related problems are considered. Data of various investigators on frequency of spontaneous and radiation-induced aberrations are tabulated. Factors possibly responsible for discrepancies in the data are discussed. (A.G.W.)

25015 CHROMOSOME CYTOLOGY OF MEDICAL ANOMALIES. G. Yerganian (Children's Hospital, Boston). p.237-70 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

The following points are discussed in this review of the field: sex chromosome and sex chromatin patterns, cytological phenomena being considered as inherent features that may encourage formation of the more prevalent types of syndromes, chromosomal anomalies in human malignancies, cellular and chromosomal features of current experimental tissues, quasidiploidy in relation to the origin of some human syndromes and malignancies, satellited chromosomes, and the Triheterosomic scheme for sex determination in man. (A.G.W.)

25016 GENERAL SURVEY OF GENETIC EFFECTS OF CHROMOSOMAL ABERRATIONS. D. L. Lindsley (Oak Ridge National Lab., Tenn.). p.273-89 of "Radiation-induced Chromosome Aberrations." New York, Columbia University Press, 1963.

Genetic effects of radiation on mature Drosophila sperm are discussed. It is concluded that single breaks that occur too far from another break to interact with it, if they occur, do not remain open, do not form dominant lethals, and thus by a process of elimination must restitute. When there are two broken strands within a site, three types of intrabrachial rearrangement are possible: (1) they may reunite to form a chromosome unchanged except for mutational scars, (2) they can rejoin to produce an acentric ring and a rod deficient for the region included in the ring, or (3) they may rejoin to form an inversion. Interbrachial rearrangements and the situation where, within a site, there are two different arms are also considered. Two such breaks may restitute, they may rejoin to produce a dicentric and an acentric, or they may form reciprocal translocations. Translocations between the x chromosome and the autosomes are used to illustrate how the genetic effects of aberrations may affect the validity of scoring procedures. (A.G.W.)

25017 RADIATION EFFECTS IN PHYSICS, CHEMISTRY AND BIOLOGY. PROCEEDINGS OF THE SECOND INTERNATIONAL CONGRESS OF RADIATION RESEARCH, HARROGATE, GREAT BRITAIN, AUGUST 5-11, 1962. Michael Ebert and Alma Howard, eds. Amsterdam, North-Holland Publishing Co., 1963. 521p. $14.00.

Twenty-five review papers are included, which summarize the important content of more than 300 individual papers presented at the meeting. The discussions following each report are summarized. A separate abstract was prepared for each review paper. (A.G.W.)

25018 LINEAR ENERGY TRANSFER. L. F. Lamerton (Royal Cancer Hospital, Sutton, Surrey, Eng.). p.1-17 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Ten papers presented at the Second International Congress of Radiation Research are summarized. The main areas of work covered are (1) comparison of dose-response curves for a range of linear energy transfer values and with a variety of biological materials, including a number of types of mammalian cells in culture, plant material, and bacteria, and (2) modification of these curves by various factors, including fractionation and protraction of the radiation dose, degree of oxygenation, and culture conditions. (A.G.W.)

25019 DOSE RATE AND TIME FACTOR. R. H. Mole (Medical Research Council, Harwell, Berks, Eng.). p.18-33 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Nine papers presented at the Second International Congress of Radiation Research are summarized. The work covered deals with x and γ radiation and with several different biological systems, including Drosophila eggs, mice, birds, Paramecium, and silkworm larvae. In general it is concluded that changes in instantaneous dose rate from 1 rad/sec up to 10^5 rad/sec produce surprisingly little change in effect. On the other hand, the demonstration of even a relatively small change in mutation rate with variation in exposure time confirms current ideas that genetic mutation is not the instantaneous, permanent, and invariant response postulated by classical theory. Experiments on recovery from radiation and possible mechanisms of recovery are discussed briefly. (A.G.W.)

25020 PRIMARY SPECIES IN WATER. F. S. Dainton (Univ. of Leeds, Eng.). p.34-54 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Fifteen papers presented at the Second International Congress of Radiation Research are summarized. Data obtained by single electron pulse radiolysis of various aqueous systems are presented. Results of irradiation of liquid water with light of wavelength 1850 Å are described briefly. Several studies of irradiation of aqueous systems at temperatures in the range −20° to −196°C are compared. Other work reviewed includes several studies of the radiolysis of CO and CO_2 solutions, radiolysis of N_2O solutions, reactiv-

ity of solvated electrons and hydrogen atoms formed by irradiation, x-ray-induced oxidation of formate in the presence and absence of beef liver catalase, and products of 50-kvp x irradiation of aqueous L-lysine hydrochloride. (A.G.W.)

25021 SOLUTE KINETICS. H. C. Sutton (Univ. of Edinburgh). p.56-70 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Fourteen papers presented at the Second International Congress of Radiation Research are summarized. The effects of solute concentration on product yields in radiolysis of aqueous solutions were studied in solutions of KI, sodium chloraurate, and chloride, bromide, and thallous ions. Study of competition between two solutes for the same free radical was used by several investigators as a general method of comparing reaction rates of H and OH radicals. Systems used in these studies included air-free solutions of KBr under high pressures of hydrogen, solutions of iodo-benzoic acid and iodo-phenetole, aerated solutions of alkaline sodium sulfite, ferric sulfate solutions with vinylpyridine sulfate added and nitric oxide solutions. Radiolysis of sodium tellurite and potassium ferricyanide in alkaline solutions was studied. Two papers on chemical dosimetry dealt with a ferrous sulfate dosemeter and induction of fluorescence in solutions of hydroxy benzoic acid. (A.G.W.)

25022 RADIATION CHEMISTRY OF MACROMOLECULES. A. Charlesby (Royal Military Coll. of Science, Shrivenham, Wiltshire, Eng.). p.72-95 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Ten papers presented at the Second International Congress on Radiation Research are summarized. Work covered includes the following: radiation effects on a polycarbonate, including G values, changes in mechanical properties, optical changes, and gas evolution; electron spin resonance data on trapped intermediate radicals in irradiated polymethylmethacrylate; studies, using pulsed radiation, of parameters influencing the degree of polymerization of styrene; effect of dose rate on the tensile strength and viscosity of various polymers irradiated in the presence of oxygen; inter- and intramolecular energy transfer in irradiated polymethylmethacrylate; a technique for determining overall radiation damage in polymers based on use of nuclear quadrupole resonance; effect of solvents on the behavior of polymers (particularly polyvinyl chloride) irradiated in solution; dose rate effects in irradiation of β-lactoglobulin; radiation effects on collagen; effects of uv and ionizing radiations on DNA in vivo. (A.G.W.)

25023 DNA AND THE EFFECTS OF RADIATION. K. A. Stacey (Hammersmith Hospital, London). p.96-113 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Ten papers presented at the Second International Congress of Radiation Research are summarized. Work covered concerns the following: radiation effects on DNA in the cell; cross-linking of DNA induced by uv irradiation; effects on nucleoprotein; modes of radiation damage to DNA; post-irradiation metabolism of DNA; radiation effects on splenic deoxyribonuclease II in irradiated rats; and sensitization of cells to uv radiation by bromouracil. (A.G.W.)

25024 CELL DEATH AND MUTATION. Tikvah Alper (Hammersmith Hospital, London). p.114-34 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North Holland Publishing Co., 1963.

Eleven papers presented at the Second International Congress of Radiation Research are summarized. The papers deal with the following: radiobiological consequences of inducing cells to incorporate unnatural base analogs in the DNA; correlation between DNA base composition and its sensitivity to x rays; combined effects of radiation and HN_2 on cells of yeast and E. coli; growth and division in total irradiated population of Chinese hamster cells; chemical tests on DNA irradiated in vivo and in vitro; effects of radioelements incorporated in nucleic acids on cells; radiation-induced mutations in microorganisms. All results are considered in relation to possible mechanisms of cell death and mutation. (A.G.W.)

25025 CELLULAR AND MACROSCOPIC DAMAGE IN RELATION TO CYTOLOGICAL OBSERVATIONS. H. J. Evans (Medical Research Council, Harwell, Berks, Eng.). p.136-51 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Nine papers presented at the Second International Congress of Radiation Research are summarized. The papers covered deal with the following: relation between LD_{50} and DNA content for 40 higher plant species; chromosome damage as a cause of cell death; correlation between radiosensitivity and cell ploidy; radiation effects on proliferative capacity of cells. (A.G.W.)

25026 STAGES IN THE CELL CYCLE AND GERM CELL DEVELOPMENT. Charlotte Auerbach (Inst. of Animal Genetics, Edinburgh). p.152-68 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Twelve papers presented at the Second International Congress of Radiation Research are summarized. The first of three groups into which the papers are arranged deals with radiosensitivity differences between stages of meiosis in the female. The wasp Habrobracon and the crustacean Artemia are used in the investigations. The second group deals with sensitivity differences between the germ cell types from early spermatogonia to mature spermatozoa. One worker, using mice, scores effects presumably due to translocations, and two Drosophila workers score mutations as the criterion of damage. One paper is concerned with death of irradiated germ cells in relation to the temporal pattern of DNA synthesis. The third group deals with sensitivity changes during the mitotic cycle. Two papers describe results obtained by a double-labelling technique. All but one use cell death and mitotic delay as criteria of damage. One measures the rate at which broken chromosomes rejoin at different stages in the cell cycle. (A.G.W.)

25027 METABOLIC CONDITIONS BEFORE AND AFTER IRRADIATION. Margaret J. Thornley (Low Temperature Research Station, Cambridge, Eng.). p.170-92 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Nine papers presented at the Second International Congress of Radiation Research are summarized. The papers deal with the importance of metabolic processes in both initial radiation damage and the process of repair. Specifically, studies of the following are reported: aberrations in Tradescantia anthers x irradiated in various gases and post-treated with CO; effects of various modifying agents on radiation-induced lethals in Drosophila males; effects of age of culture and metabolic inhibitors on radiation-

induced mutations in yeast; effects of post-irradiation incubation at 25 and 37° on survival of rat thymocytes; effects of subcellular fractions of the L strain cells, used as additives after irradiation, on survival of L strain mouse fibroblasts; effects of precultivation conditions and post-irradiation incubation in tap water on reactivation of yeasts; effects of growth medium before irradiation on subsequent survival of E. coli; effects of anaerobic compared with aerobic incubation before and after irradiation in air on survival of E. coli; effects of plating medium on survival of proline-deficient E. coli x irradiated under anoxic conditions. (A.G.W.)

25028 ELECTRON SPIN RESONANCE IN BIOLOGY. J. W. Boag (Mount Vernon Hospital, Northwood, Middx, Eng.). p.194-214 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Twelve papers presented at the Second International Congress of Radiation Research are summarized. The principle of the electron spin resonance (ESR) method is explained briefly, and one paper reports improvements in techniques. The present status of the standardization program in which seven laboratories are participating is presented. Other papers deal with use of ESR to study radicals produced by irradiation of palmitic acid, tripalmitin, potassium palmitate, succinic acid, glutathione, penicillamine, various amino acids, seeds, keratin, and T_2 phage DNA. (A.G.W.)

25029 INHIBITION OF DNA SYNTHESIS IN RELATION TO CELL DEATH. L. G. Lajtha (Christie Hospital and Holt Radium Inst., Manchester, Eng.). p.216-33 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Thirteen papers presented at the Second International Congress of Radiation Research are summarized. It is concluded that DNA synthesis may be affected by radiation in different ways, depending on the cell type used, on the milieu in which the cells are kept, on the cell cycle state, and on the quality and quantity of radiation. Cell cycle delay may vary with the state of cell cycle during irradiation, on the time after irradiation when the phenomenon is investigated, and possibly on the cell type studied. It is likely that several different and perhaps unrelated mechanisms are involved. Although some correlation between immediate cell cycle delay and chromosome damage can be established, this will vary with the quality and dose rate of radiation used. Neither of these parameters, nor inhibition of the rate of DNA synthesis, can be correlated with loss of reproductive integrity. (A.G.W.)

25030 EFFECTS ON ORGANIZED SYSTEMS IN THE LIGHT OF CELLULAR RADIOBIOLOGY. H. B. Hewitt (Westminister Hospital, London). p.234-52 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Fifteen papers presented at the Second International Congress of Radiation Research are summarized. Work covered deals with radiosensitivity of mouse cells, radiation effects on bean root cells, radiation response of adult rat thyroid glands, control dose of radiation for tumors, effects of oxygen and dose fractionation on tumor response to radiation, and radiation effects on skin and skin tumors. (A.G.W.)

25031 CHEMICAL PROTECTION IN CHEMICAL SYSTEMS. P. Alexander (Inst. of Cancer Research, London). p.254-74 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Eleven papers presented at the Second International Congress of Radiation Research are summarized. In general the papers are concerned with the mechanisms by which protection against radiation damage can occur in model systems. Specific subjects of study include protection of red blood cells against hemolysis, protection of polyvinyl pyrrolidone against crosslinking, protection of glucose by additives, x-radiation effects on vitamins, effects of benzene on radiolysis of cyclohexane and ethanol, effects of solvent composition on polymerization of styrene, radiation protection by cysteamine of DNA and salmine, protection of dimethylsiloxane against cross-linking, and nutritional value of meat sterilized by radiation. (A.G.W.)

25032 CHEMICAL PROTECTION AT THE CELLULAR LEVEL. E. A. Wright (St. Mary's Hospital Medical School, London). p.276-92 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Thirteen papers presented at the Second International Congress of Radiation Research are summarized. The papers deal mainly with the mechanism of chemical protection of isolated cells against radiation. Three groups of substances were studied by the thirteen authors: (1) protective agents (sulfhydryl compounds, anoxia, glycerol-like compounds, amidines, cooling, freezing, drying, thiourea, and like compounds); (2) sensitizing agents (oxygen, nitric oxide, N-ethyl maleimide); (3) inactive compounds (cystamine, cystine, and pharmacologically active amines. Some inconsistencies were found, but, in general, the papers provide new evidence that sulfhydryl compounds protect in the presence and absence of oxygen. A series of amidines and related compounds were found to protect E. coli. (A.G.W.)

25033 CHEMICAL PROTECTION IN MAMMALS. O. C. A. Scott (Mount Vernon Hospital, Northwood, Middx, Eng.). p.294-308 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Nine papers presented at the Second International Congress of Radiation Research are summarized. Five of the nine papers are concerned with the relationship between mammalian protection and tissue anoxia. There is fairly general agreement that the majority of pharmacologically active compounds or anesthetics act by inducing tissue anoxia. Nitrous oxide may protect by an independent mechanism. The cysteine–cysteamine group does not appear to produce tissue anoxia. Polarographic measurements of splenic oxygen tissue provide the most direct evidence on this point. The protective effects of mixed disulfides were tested inconclusively. Tracer studies to determine the metabolic products of mercaptoethylguanidine and guanidoethyldisulfide were carried out. A new technique for measuring radiation effects using Cr^{51} is discussed briefly. (A.G.W.)

25034 THE EFFECT OF AGE ON RADIOSENSITIVITY. J. F. Fowler (Hammersmith Hospital, London). p.310-32 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Twelve papers presented at the Second International Congress of Radiation Research are summarized. The radiosensitivity of functions in mice other than the previously investigated $LD_{50/30}$ was studied. Functions that showed an age dependency similar to the LD_{50} included gastrointestinal death, granulocyte and lymphocyte concen-

tration, sterility, and total reproductive capacity. Immune response, lens weight, and intercapillary glomerular sclerosis varied with age differently from the LD_{50}. Three physiological parameters that might cause radiosensitivity to vary with age were studied: oxygen tension in vital organs, rate of increase of weight, and hormonal factors. Similar studies on rats indicate that the age variation of radiosensitivity differs from that in mice over the first few weeks of life. Effects of irradiation of the mouse fetus at various ages during gestation are summarized. (A.G.W.)

25035 RADIATION HAEMATOLOGY. E. V. Hulse (Medical Research Council, Harwell, Berks, Eng.). p.334-51 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Twelve papers presented at the Second International Congress of Radiation Research are summarized. Work covered deals with the following: radiation effects on peripheral blood of guinea pigs, dogs, and swine; comparison of neutrophils in irradiated dogs and monkeys; correlation of bone marrow response to radiation with mean lethal dose; radiation effects on lymphocytes of guinea pigs; bone marrow response of patients receiving therapeutic irradiation; radiation effects on fetal hemopoiesis in mice; platelet size in normal and x-irradiated dogs; radiation effects on Fe metabolism in rabbits and rats; γ-radiation effects on reaction time of oxyhemoglobin with nitrites. (A.G.W.)

25036 RADIATION CHIMAERAS. D. W. H. Barnes (Medical Research Council, Harwell, Berks, Eng.). p.352-71 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Eleven papers presented at the Second International Congress of Radiation Research are summarized. Work covered deals with the following: therapeutic effect of bone marrow transplantation following fractionated irradiation; identification of hematopoietic grafts; number and origin of cells required to save irradiated mice; effect of reticuloendothelial stimulation on survival of injected foreign bone marrow; effectiveness of autografts in dogs; secondary disease and its avoidance; skin grafts in chimaeras; acquired and specific tolerance of cell grafts. (A.G.W.)

25037 CARCINOGENESIS. J. F. Loutit (Medical Research Council, Harwell, Berks, Eng.). p.372-90 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Sixteen papers presented at the Second International Congress of Radiation Research are summarized. Eight papers deal with carcinogenic effects of external irradiation. Incidence of leukemia in mice, mammary tumors in rats, and miscellaneous tumors in rats was studied. Eight papers are concerned with internal sources of radiation. Two investigators found that tritium- or C^{14}-labelled thymidine induced leukemia or tumors in mice. Effects of bone-seeking radionuclides were studied. A diet low in phosphorus and daily injections of diethylene-triamine-pentacetic acid appeared to lengthen life span and reduce tumor incidence in mice injected with Sr^{90} and Pu^{239}. Results of a study of $Ce^{144}Cl_3$-induced lung cancer are summarized. (A.G.W.)

25038 IRREPARABLE DAMAGE OTHER THAN MALIGNANT DISEASE. J. S. Mitchell (Cambridge Univ., Eng.). p.392-406 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Fifteen papers presented at the Second International Congress of Radiation Research are summarized. Work covered deals with the following: early x-ray effects on the aortal intimal matrix in dogs; effect of dietary-induced growth retardation on radiosensitivity of mice; effect age at time of x irradiation on acceleration of intercapillary glomerulosclerosis; effects of x irradiation on 4-day-old rats; life-span of the progeny of irradiated rats; recovery half-time for irradiated dogs; effects of splenectomy and appendectomy on radiation response of mice; pathological effects of x rays on lungs of rats; effect of oxygen tension on radiosensitivity of dog kidneys; radioinduced chromosome aberrations in regenerating liver; relative biological effectiveness of fast neutrons of different energies in relation to Co^{60} γ rays for late somatic effects in mice; lens opacification response of rats to fast neutrons; late effects of incorporated α emitters on bone. (A.G.W.)

25039 IRREPARABLE DAMAGE TO THE REPRODUCTIVE ORGANS. E. C. Amoroso (Royal Veterinary Coll., London). p.408-29 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Thirteen papers presented at the Second International Congress of Radiation Research are summarized. Work covered deals with the following: radiation effects on ovaries of mice; reproductive capacity of mice as a function of age at time of irradiation; radiosensitivity of the pre-ovulatory follicle in rats; fertility studies of mice and rats exposed to chronic whole-body γ radiation for 23 hr daily; radiation effects on fertility of mice; lifespan and sex ratio of off-spring of irradiated male mice; cytogenetic studies of radium dial painters and their progeny; distinction between maternal and embryonic response of mice to x irradiation; effect of hypoxia, cysteamine, AET, and DNA on fertility of irradiated mice. (A.G.W.)

25040 EFFECTS ON ENZYMES. H. Laser (Cambridge Univ., Eng.). p.430-48 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland, Publishing Co., 1963.

Fourteen papers presented at the Second International Congress of Radiation Research are summarized. Work covered deals with the following: radiation effects on dry materials including yeast invertase, amino acids, peptides, and proteins; disturbance of protein and amino acid metabolism in irradiated animals; decarboxylation of amino acids in the spleen of irradiated mice; dose and time dependence of nitrogen excretion in perfused frogs liver following irradiation; radiation response of auxin formation by animal tissues; the release of RNAase bound in the nucleus of lymphoma cells following x irradiation; post-irradiation changes of mitochondrial lipids; x radiation effects on synthesis of RNA and total protein, on the formation of an inducible enzyme (lysin decarboxylase), and on colony formation in B. cadaveris; effect of x and uv irradiation on lactic dehydrogenase in solution; properties of x irradiated glutamic dehydrogenase; radioinduced inactivation of acetylcholinesterase acting on three different substrates; kinetics of enzyme inactivation in solution by ionizing radiation. (A.G.W.)

25041 OBSERVATIONS ON MAMMALS. O. A. Trowell (Medical Research Council, Harwell, Berks, Eng.). p.450-60 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Nine papers presented at the Second International Congress of Radiation Research are summarized. Work covered deals with the following: effect of age on mean survival time of mice after 1000 r of whole-body x irradiation; loss of Na from the gastrointestinal tract of irradiated rats; intestinal absorption of fat in irradiated mice; effect of diverting bile flow from the intestine on diarrhea in irra-

diated rats; gastric secretion of irradiated rats; effects of intestinal β radiation from Y^{90} in rats; tumor production by x irradiation of exteriorized small intestine of rats; histochemical changes in liver following irradiation. (A.G.W.)

25042 INGESTED ISOTOPES. Janet Vaughan (Medical Research Council, Churchill Hospital, Oxford). p.462-80 of "Radiation Effects in Physics, Chemistry and Biology." Amsterdam, North-Holland Publishing Co., 1963.

Nineteen papers presented at the Second International Congress of Radiation Research are summarized. One group of papers is concerned with the kinetics of Ca, Sr, and Ra metabolism in humans. Mice were used in an attempt to correlate the retention observed using single intravenous injections of Ra with that observed in continuous feeding experiments. Another group of papers deals with observed effects of bone-seeking radionuclides on the skeleton. Most of these studies involved dogs and mice. Some data are included on radiographic changes in the skeletons of 236 persons employed in the watch dial industry before 1925. Two papers deal with treatment of radionuclide-injected animals using diethylenetriamine-pentacetic acid and a low-phosphorus diet. (A.G.W.)

Radiation Sickness

25043 (TID-18699) EVALUATION OF ERYTHROPOIETIC DAMAGE AND RECUPERATION FOLLOWING X-IRRADIATION. T. G. Hennessy, S. E. Herrick, and J. P. O'Kunewick (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [Apr. 26, 1963]. Contract AT(04-1)-Gen-12. 12p.

It was shown that the total uptake of Fe^{59} following x irradiation is dependent not only upon the irradiation dose received, but also upon the time of isotope injection. When animals were injected 24 hours after x irradiation, they show, for all x-ray dose levels studied, decreased uptake of the Fe^{59} both at 1 day following injection and at two weeks post-injection. However, when the injection of radioiron is done at 5 days post-irradiation, there is no significant depression at the same sampling periods for irradiation doses of 300 r or less. In addition, it was noted that the general shape of the uptake versus x ray dose curve at 14 days after injection closely paralleled the curve obtained when sampling was done 1 day after injection. The only significant difference in this case was that the total uptake at 14 days was consistently greater than at 1 day, as might be expected. Comparison of the curves for the 24 hour injection with the fifth day injection curves demonstrated that radioiron uptake following injection at five days could not be predicted from the data obtained from a 24 hour injection, and vice versa. It was also found, in both cases, that when the first injection was followed by a second 17 days later, the uptake curves of the two injections showed a marked divergence up to the point of lethal irradiation dosages. At or near the point of lethal x ray dosage the curve from the second injection showed a marked change in slope culminating in noticeably lower Fe^{59} uptake. While giving no absolute index of the total physical dose received, this latter phenomenon could be utilized to give an approximate indication of both the amount of irradiation received and the ability of the individual animal to recover. (auth)

25044 (JPRS-19363) PRIMARY PROCESSES OF RADIATION INJURY. B. N. Tarusov. Translation of p.85-93; 94-6 of "Pervichnye Protsessy Luchevogo Porazheniya" Moscow, 1963. 28p. (OTS-63-21900).

Data are reported concerning primary radiochemical reactions arising in cellular substrates. Mechanisms involved in primary processes are reviewed. Results are included from studies on the effect of temperature and oxygen on development of radiochemical reactions with time and directly after irradiation. The role of primary radical formation and the reactive capacity of the biological substrate in radiation injuries are discussed. The significance of oxidizing reactions and radiation effects on lipids are also considered. (C.H.)

25045 EFFECTS OF WHOLE-BODY IRRADIATION AND OF AET ON THE ACTIVITY OF THYMIDINE KINASES IN REGENERATING LIVER. R. Goutier, L. Baugnet-Mahieu, and M. Semal (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). Arch. Intern. Physiol. Biochem., 71: 130-1(Jan. 1963). (In French)

Rats were injected with 100 mg/kg AET (aminoethylisothiuronium) dihydrochloride 10 min before exposure to a whole-body dose of 1000 r, partially hepatectomized 1.5 to 2 hr after irradiation, and sacrificed 12 to 48 hr later. In homogenates of the regenerating liver, the activity of thymidine kinases was measured and expressed as the proportion of thymidine converted to mono-, di-, and triphosphates (TMP, TDP, and TTP). The kinases of nonirradiated liver removed 24 hr after hepatectomy converted 47% of the thymidine to TMP, 4.5% to TDP, and 2.1% to TTP, giving a total conversion of 54% to the nucleotides. At this time the activity was highest; at 36 and 48 hr of regeneration the phosphorylation of thymidine reached 50 and 36%, respectively. In irradiated liver at 24 hr after hepatectomy the kinase activity was very low, as previously shown, with only 3 to 4% phosphorylation of thymidine. But this reflects only a delay in the appearance of the enzyme, since at 36 hr a value of 23% is reached and at 48 hr the value is 47%, which is higher than in nonirradiated liver. Injection of AET did not prevent the depletion of kinase activity caused by irradiation; in fact, the percentage of thymidine phosphorylated was lower when AET was given. Injection of AET in nonirradiated rats produced almost 50% inhibition of kinase activities. (TCO)

25046 WHOLE-BODY X IRRADIATION AND AMYLOIDOSIS. Martti Turunen and Harald Teir (Univ. of Helsinki). Arch. Pathol. Anat. Physiol., 334: 251-5(1961).

The development of amyloidosis secondary to irradiation and casein injection was studied in C3H mice. One group of mice received an initial whole-body dose of 316 r followed by weekly doses of 185 r. After 6 weeks, some of the mice were injected every other day with 1 ml 5% casein solution. Other mice were given only casein injections. Three to 5 weeks after beginning the injections, histologic examination was made of liver, spleen, heart, kidney, and intestine. In animals receiving radiation alone, parenchymal degeneration in liver and kidney, as well as extensive necrosis in spleen, was seen but no evidence of amyloid was found in any organ. Severe amyloidosis was present in organs of 50% of mice given only casein injections, and was first seen 3 weeks after the injections began. In mice receiving both irradiation and injections, the casein was less well tolerated and in many cases caused death. Amyloid tended to be deposited in the same sites that showed degeneration and necrosis after irradiation alone. It was most severe in spleen, less so in liver and kidney, in that order. None of the animals given combined treatment survived the 5-week course of injections. The results show that irradiation accelerated the deposition of amyloid. (TCO)

25047 CANINE LIVER HOMOTRANSPLANTS: THE EFFECT OF HOST AND GRAFT IRRADIATION. T. E. Starzl (Univ. of Colorado, Denver), G. W. Butz, Jr., D. R.

Brock, J. T. Linman, and W. T. Moss. Arch. Surg., 85: 460-4(Sept. 1962).

Host-vs-graft reactions were studied in dogs given whole-organ transplants after lethal whole-body x irradiation. Six recipient dogs were given 1400 r; 18 to 40 hr later total hepatectomy was performed and a liver transplanted from a normal dog. All animals died within 36 hr from diffuse gastrointestinal hemorrhage or hemorrhagic pneumonitis. The combination of operative trauma and irradiation appeared to preclude even temporary success. Twelve donor dogs were given 1400 r, and 18 hr later, their livers were transplanted to normal hosts. Six dogs died within 30 hr of hemorrhagic gastroenteritis. The other 6 recovered and were the subject of further study until their later death. The 6 dogs that survived the immediate effects of surgery lived for 5 to 13½ days. Clinical behavior was similar to that previously observed with the use of nonirradiated grafts and was characterized by fever, eventual lassitude, cessation of oral intake, and jaundice. All dogs surviving >5 days had progressive elevation of serum bilirubin and alkaline phosphatase after 5 to 6 days. After 4 to 6 days, bile was detected in the urine. Before death, all 6 dogs had rises in the white count to as high as 45000/mm^3. Their livers were usually large, firm, and pale or mottled. Ascites was present. Histologic evidence of host response was also found in 5 of the 6 animals surviving 5 days or more. The findings indicate that a graft-vs-host reaction is not of immediate significance even with as bulky a graft as the liver. Histologic changes in the liver graft, as well as those in various host organs, appear to be attributable exclusively to host activity in response to the antigenic stimulus of the liver.

25048 RADIATION INJURIES IN THE PIG AND THEIR MODIFICATION BY AMINOETHYLISOTHIURONIUM CHLORIDE-HYDROCHLORIDE. W. Braun, J. Staubesand, and V. Wolf (Universität, Hamburg). Arzneimittel-Forsch., 11: 630-42(July 1961).

Studies were performed to ascertain whether aminoethylisothiuronium chloride-hydrochloride (AET-HCl) provides protection against ionizing radiation in pigs; 300 pigs were used and x-ray doses of 500 to 1000 r. The $LD_{50/30}$ for the 5- to 7-week-old animals was found to be 720 r following unilateral irradiation in the dorsoventral direction. Increase in weight was disturbed by radiation in relation to the dose and attained a normal rate only after 3 to 4 weeks. Changes in the blood count showed the well-known marked decrease of leukocyte values, with slow recovery. Relative lymphocytosis and increase of young cells, both dependent on the dose, were observed. The onset of changes in the red blood count was slower. Serum protein values and albumin fraction were also reduced. Several pathologic changes were found. After tests of acute toxicity, AET-HCl was given in doses of 100, 200, and 300 mg/kg orally before the onset of radiation. It improved the survival rate and gain in weight compared with controls submitted to the same radiation doses. The protection was not as marked as usually found with AET-HCl in tests on mice and rats: furthermore, no dependence on the dose of AET-HCl was seen. Blood count and blood serum tests revealed no protective action of AET-HCl. Lymphocytosis of the treated animals surpassed that of the controls. (TCO)

25049 ASSESSMENT OF SPLEEN SHIELDING AND HOMOLOGOUS SPLENIC HOMOTRANSPLANTS IN THE PROTECTION AGAINST LETHAL TOTAL BODY IRRADIATION. D. R. McNaught, F. W. Turner, and S. Kling (Univ. of Alberta, Edmonton, Can.). Can. J. Surg., 5: 334-9(July 1962).

Experiments were conducted to study the effects of shielding the spleen of dogs subjected to lethal doses of whole-body irradiation, and to give lethally irradiated animals an infusion of shielded spleen taken from the survivors of the procedure to determine whether the spleens have any special properties that would make them of more value than the ordinary spleen used as homotransplants. Cs^{137} radiation was given at a rate of 8.33 r/min. All control dogs irradiated with 600 r died between the 9th and 11th day after irradiation. However, when the exteriorized spleen was shielded during 600-r irradiation, 57% survived. The survival rate was 33.3% when 1000 r was given with the spleen being shielded, but none survived 1225 r under the same conditions. Injections of homogenized shielded spleen did not prevent death in dogs exposed to 600 or 1000 r. Mechanical shielding of the spleen had a definite influence on the clinical appearance and the survival rate of the irradiated dogs at lower dose levels. The failure of the homologous spleen homografts to prolong survival time of the recipient dogs could be a result of inadequate irradiation of the animals, which failed to destroy their immune response completely. (TCO)

25050 EFFECT OF HOMOLOGOUS BONE MARROW OF TOLERANT DONORS ON THE SURVIVAL OF IRRADIATED MICE. J. F. Duplan, V. P. Rechtikov, and G. Kosinetz (Institut du Radium, Paris). Compt. Rend. Soc. Biol., 156: 1773-5(1962). (In French)

Male and female mice of the XVII strain were exposed to a single x-ray dose of 800 r. Two to four hours after irradiation the mice were injected with a bone marrow suspension. The animal survival was evaluated on the 30th and 100th day after irradiation. Tolerance was obtained by injecting homologous bone marrow into newly born C57 BL mice, which were then used as donors. The study was made on four experimental groups. In the first group the XVII mice received XVII isologous bone marrow. In the second group the injected cells were from C57 BL mice. The third group received at birth an injection of C57 BL bone marrow to make them tolerant to the cells of their future donor. The last group received bone marrow from C57 BL mice that were made tolerant to XVII cells. The survival results are tabulated and show that the first group had 92% survival on the 30th and 100th day. There were no survivors in the second and third group on the 100th day. All the mice dying between the 30th and 100th day showed signs of secondary radiation sickness. Twenty-nine percent of the last group were living on the 100th day. In the second and third group more than half of the animals died between the 16th and 30th day, whereas in the 1st and 4th group, the mean survival time was 7 and 12 days, respectively. (J.S.R.)

25051 THE REACTION OF THE SPERMATOGENETIC EPITHELIUM IN MICE TO PROLONGED CHRONIC IRRADIATION WITH SMALL DOSES OF Co^{60} GAMMA-RAYS. L. Ya. Zhorno and K. K. Surikova (Inst. of Cytology, Academy of Sciences, USSR and Inst. of Health Physics, Leningrad). Dokl. Akad. Nauk SSR, 150: 170-3(Mar. 1, 1963). (In Russian)

White mice 20 to 22 grams in weight were kept near a Co^{60} source, and were given a total dose of 3.6 r over a period of 6 months. A histological study of the seminal canals showed that the distribution of spermatogonia, spermatocytes, spermatids, and spermatozoids in the seminal canals of irradiated mice was the same as that in the unirradiated mice. These irradiated mice, and a group of control mice were then subjected to a single x-ray dose of 400 and 600 r. On the 30th day after the irradiation with

a 600 r dose, it was found that the number of seminal canals not containing spermatogonia was a factor of 1.6 greater in the experimental group than in the control group (31.6 and 19.2% respectively). On the 30th day after irradiation with a dose of 400 r, the seminal canals not containing spermatocytes was a factor of 2 greater in the experimental group than in the control group (49.5% for the experimental group, and 23.7% for the control group). Thus, a relatively small dose administered over a long period of time showed no morphological changes, but the irradiated tissue turned out to be sensitive to an additional large dose of radiation. The radiation damage shows up as a difference in the development of regenerative processes after a traumatic shock. (TTT)

25052 ON THE THERAPY OF INTESTINAL SYMPTOMS IN THE FRAME OF RADIATION SICKNESS. K. Fochem (Universität, Vienna). Med. Klin. (Munich), 58: 528-9(Feb. 1963). (In German)

The therapy of intestinal symptoms in radiation sickness is reported, for which the preparation Arobon, an agent for effectively combating the painful tenesmus and diarrhea, is available. The effectiveness of this agent was tested on 117 patients, who were irradiated at the clinic because of genital carcinomas. The agent was tolerated very well and taken gladly by the patients. Side effects were not observed. An attempt was made to explain the mode of action of the preparation, which contains Ceratonia siliqua, cacao, mineral salts, lignin, hemicellulose, cellulose, pectin, proteins, fats, soluble carbohydrates, and water. (tr-auth)

25053 THE EMPLOYMENT OF SEROTONIN IN THE PROPHYLAXIS OF ACUTE RADIATION SICKNESS IN MONKEYS. L. F. Semenov, L. F. Larionov, M. F. Petrova, E. Ch. Pukhalskaya, and K. A. Zeitunyan (Inst. of Experimental Pathology and Therapy, Academy of Sciences, USSR and Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol., 8: No. 4, 58-62(Apr. 1963). (In Russian)

5-hydroxytryptamine hydrochloride was used intramuscularly for the prevention of radiation sickness in 48 macaque monkeys in doses ranging from 35 to 175 mg/kg. Serotonin produced a marked protective effect with a dose of 35 to 40 mg/kg in total gamma irradiation (630 r: LD-90%). The protective action was manifested by alleviation of symptoms of radiation sickness and survival of 35% of the animals in comparison with irradiated control animals. (P.C.H.)

25054 TESTS WITH TRYPTAMINE (CHLOROHYDRATE OF 3-(2-AMINOETHYL)INDOLE) IN ACUTE RADIATION SICKNESS IN MICE. V. V. Antipov. Med. Radiol., 8: No. 4, 81-2(Apr. 1963). (In Russian)

Effects of chronic application of tryptamine (similar to serotonin preparation capable of penetrating the marrow and spleen) on hemorrhage (petechia) in irradiated mice were studied with 176 mice weighing 18 to 22 g and exposed to total doses of 600 and 650 r. The results showed that intravenously injected 10 to 25 mg/kg doses of tryptamine did not prevent the petechia and produced stronger toxic effects on exposed mice than on intact ones. (R.V.J.)

25055 EFFECTS OF ULTRA-VIOLET IRRADIATION ON THE COURSE OF RADIATION SICKNESS. V. D. Abdullaev. Med. Radiol., 8: No. 4, 82-3(Apr. 1963). (In Russian)

Prophylactic effects of large doses of ultraviolet rays were studied with 42 white rats divided into three groups. One group was exposed to uv after exposure to 500 r of x rays and another before x-ray exposure; the third group was a control group. The rats were treated with 24,000,000 erg/cm^2 ultraviolet rays during 12 treatments. Sixty days after the exposure to x radiation all rats of the control group survived and only 10 rats of the first group and 14 of the second group survived. The mean life of the perished animals was 14.9 days for the first group and 8.8 days for the second. (R.V.J.)

25056 EFFECTS OF WHOLE BODY X-IRRADIATION WITH SUBLETHAL DOSES ON THE CELLULAR AND HUMORAL BLOOD-COUNT OF SPRAGUE-DAWLEY RATS. L. Nowrousi. Thesis, Bonn, Universität, 1961. 30p. $2.00.

Changes of the blood count of Sprague-Dawley rats after x irradiation with various sublethal doses (100 to 400 r) were studied. The results from cellular blood counts are in agreement with the results given in the literature. No significant decrease of γ globulins was observed after irradiation. (Gmelin Inst.)

CHEMISTRY

General and Miscellaneous

Refer also to abstracts 24785 and 26770.

25057 (AERE-Bib-141) LIST OF UNCLASSIFIED DOCUMENTS PUBLISHED BY THE STAFF OF THE CHEMISTRY DIVISION DURING 1962. M. Hewitt, comp. (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1963. 23p.

A list of 198 unclassified reports, memoranda, and analytical methods, and the papers and books published by staff of the Chemistry Division at AERE at Harwell and Woolwich Outstation during 1962 is presented. An author index is also included. (P.C.H.)

25058 (ORNL-3408) TRANSURANIUM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING NOVEMBER 30, 1962. D. E. Ferguson, comp. (Oak Ridge National Lab., Tenn.). June 7, 1963. Contract W-7405-eng-26. 97p.

The development of separation processes for the transuranium elements, process-equipment development, HFIR target-fabrication development, design of the TRU facility, design of development facilities, corrosion studies, and analytical research and development are reported. (auth)

25059 (ORNL-3417) REACTOR CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 31, 1963. (Oak Ridge National Lab., Tenn.). May 1, 1963. Contract W-7405-eng-26. 339p.

Separate abstracts were prepared for thirty-three of a total of thirty-four sections in the report. The section for which no abstract was prepared concerned construction and out-of-pile testing of a third in-pile slurry loop experiment. (J.R.D.)

25060 (ORNL-3417(p.3-16)) HIGH-TEMPERATURE PHASE EQUILIBRIUM STUDIES. R. E. Thoma, H. A. Friedman, et al. (Oak Ridge National Lab., Tenn.).

Investigations of high-temperature phase equilibria were continued for systems having potential use in molten-salt-reactor technology. Emphasis shifted from studies of phase behavior in the quinary fuel system $LiF-BeF_2-ZrF_4-ThF_4-UF_4$ to the crystallization reactions in the fuel solvent system $LiF-BeF_2-ZrF_4$, and to systems involving trivalent U phases, UF_3-UF_4, $LiF-UF_3-UF_4$, $LiF-BeF_2-UF_3$, and $LiF-BeF_2-ZrF_4-UF_3$. Studies of the system $LiF-ZrF_4-UF_4$ were initiated. Studies of the systems $NaF-YF_3$ and $CsF-ZrF_4$ were completed and detailed phase diagrams were constructed. Determinations were made of the crystal structures for the compounds $LiRbF_2$, $LiCsF_2$, and Cr_2F_5 from single-crystal x-ray-diffraction data. An x-ray-diffraction study was made of the structure of Cs_3ZrF_7. The crystal and molecular structure of XeF_4 was determined from x-ray and neutron diffraction data. Characteristic optical and x-ray-diffraction properties were determined for 12 crystalline complex halide and oxyhalide phases. (auth)

25061 (ORNL-3417(p.17-40)) COMPATIBILITY OF MSRE COMPONENTS. F. F. Blankenship, S. S. Kirslis, et al. (Oak Ridge National Lab., Tenn.).

A series of three irradiations in the MTR was completed in which the interaction of fissioning MSRE fuel with INOR-8 and graphite was under study. Much of the postirradiation examination was performed. A general conclusion, which conforms to all the available evidence, is that no deleterious effects of the fuel, the graphite, or the INOR-8 will arise from irradiation behavior during the proposed operation of the MSRE with unclad graphite. A potentially serious hazard was previously recognized upon finding CF_4 in the vapor phase in capsules that were designed to study the effect of irradiation on the interfacial behavior of graphite. An even more alarming result was the subsequent discovery of high pressures of elemental F_2 in the gas spaces of other irradiated capsules. Moreover, Te caused a prominent radioactivity in the gas, and the amount of Xe was frequently far lower than expected on the basis of known fission yields. Information was obtained from the results of MTR experiment 47-5, in which provisions had been made to sweep the vapor spaces of the capsules with He and thus to collect for analysis any evolved gases. At no time when the capsules were exposed under operating conditions planned for the MSRE (fissioning molten fuel at 600 to 700°C) was there any evidence of a significant generation of F_2, CF_4, or Te, and gaseous fission products were collected in the expected amounts. By contrast, when the fuel froze during scheduled and terminal reactor shutdowns, there was abundant evidence of the generation of F_2 and release of Te, and the Xe again disappeared. Such behavior was in accord with the literature concerning the release of F_2 from irradiation of solid LiF and with the recent reports of the reactivity of Xe toward elemental F_2. The results suggest strongly that F_2 is generated by the effects of fission product radiation on frozen fuel, below temperatures of about 100°C, and that all the other anomalous results could be attributed to this primary cause. F_2 generated during the intermediate reactor shutdowns would, when the temperature was subsequently raised, have reacted more or less indiscriminately with the F_2-depleted fuel, the graphite, the Xe, and the INOR-8 walls, but ultimately virtually all was restored as fluoride in the fuel. In the cold, reaction with the graphite under decay irradiation may have produced CF_4. The absence of reaction with the INOR-8 walls indicated that the F_2 reacted very rapidly with the "reduced" fuel as the temperature was raised. Also, only in the cold, with F_2 present, was Te converted to a volatile fluoride that escaped from the solid state. An experimental program was continued to confirm and extend the reassuring conclusions from the irradiation experiments thus far completed. Evidence of a slow reaction of CF_4 with "reduced" MSRE fuel salt mixtures at temperatures of 700 to 850°C was obtained by recirculating mixtures of CF_4 and He through pots containing the molten salt but in the absence of graphite. When CF_4 was brought into contact with a similar molten salt at 600° C by introducing it through the porous walls of a submerged graphite cylinder, evidence of reaction was obtained; in blank experiments making use of an unreduced salt mixture at this temperature, no evidence of reaction was obtained. Attempts to measure the solubility of CF_4 in molten fluorides, by means of techniques which were suitable for use with the rare gases, failed to provide positive evidence of solubility; either the solubility is extremely low or the dissolved gas was somehow consumed by reaction with the system during the experimental process. The discovery of the occurrence of F_2 in the gas space above irradiated and subsequently frozen capsules containing MSRE fuel

called for the development of techniques for studying various aspects of the reactions of F_2 with MSRE materials. For such studies, apparatus was designed and constructed for the safe handling of F_2 in the laboratory. With this apparatus the preparation of XeF_4 was demonstrated, and the reaction of F_2 with frozen MSRE fuel which contained some of the U in the trivalent form was studied. Rapid reaction was indicated to begin as the temperature of the frozen salt approached the melting point of the material, suggesting that the irradiated containers found to contain F_2 when frozen were probably not exposed to high pressures of F_2 for appreciable periods at elevated temperatures following intermediate reactor shutdowns during the course of the irradiation experiment. An experimental program was conducted to study the evolution of volatile impurities from graphite by He purging while heating to 700°C at controlled rates. The apparatus and operational procedure were designed to simulate the initial preheat conditions of the MSRE. This method was found useful for studying the rates at which moisture was evolved from graphite blocks having the same cross-sectional configuration as an MSRE moderator element. Both physically adsorbed water and what appeared to be chemisorbed water were evolved during these experiments. The He preheat and purging operation planned for the MSRE should be more than adequate to remove both types of water. Studies of the precipitation of U and Zr oxides from molten mixtures of LiF, BeF_2, and ZrF_4, with varying amounts of ZrF_4 and in the presence of small amounts of MSRE fuel as a contaminant, at 600°C, have yielded results which were correlated well by simple solubility product behavior implied by the two solubility products, $Q^s_{UO_2} = [U^{4+}]\,[O^{2-}]^2 = 1.2 \times 10^{-5}$ mole^3 kg^{-3}, $Q^s_{ZrO_2} = [Zr^{4+}]\,[O^{2-}]^2 = 3.2 \times 10^{-5}$ mole^3 kg^{-3}. The consequences of this model of behavior, with reference to operation of the MSRE, are that the presence of Zr as a fuel or flush salt constituent lowers the tolerance of the salt for oxide contamination before precipitation occurs but protects against U precipitation by causing the preferential precipitation of ZrO_2. Moreover, such salts should even dissolve precipitates of UO_2, which might have been previously produced in some conceivable way, at the expense of the sacrificial precipitation of a corresponding amount of ZrO_2. (auth)

25062 (ORNL-3417(p.41-50)) PHYSICAL CHEMISTRY OF MOLTEN-SALT SYSTEMS. S. Cantor, W. T. Ward, et al. (Oak Ridge National Lab., Tenn.).

Studies of freezing-point depressions of NaF showed that 13 trifluoride solutes caused negative deviations from ideality. At a fixed solute concentration the excess partial molal free energy of mixing of NaF (calculated from the freezing-point depressions) was inversely proportional to the solute's interionic distance for 11 trifluorides (8 rare earths, Sc, Y, and La). The polarizing action of In^{3+} ions was postulated to account for the difference in the effects of InF_3 and ScF_3 on NaF freezing points. The anomalous behavior of AlF_3 in NaF solution was explained in terms of steric considerations. The magnitudes of the freezing-point depressions caused by CdF_2, which were larger than those of CaF_2, were also attributed to polarizing action. Activity coefficients of ZrF_4 in the system LiF–ZrF_4 were evaluated over the entire concentration range. From 1.0 to 0.2 mole fraction of ZrF_4, activity coefficients were calculated from published vapor pressure information. From 0.2 to 0 mole fraction, the activity coefficients were calculated by means of the Gibbs-Duhem equation. To apply this equation the necessary activity coefficients of LiF were determined for this concentration range from measurements of liquidus temperatures. The activity coefficients of ZrF_4 for the concentration range of reactor interest (5 mole % and less) were calculated to be of the order of 10^{-5}. Apparatus was constructed to measure manometric vapor pressures of fluoride melts by the Rodebush-Dixon method. Vapor pressures of two MSRE fuel mixtures (66.5-29.4-3.95-0.15 and 64.7-27.0-8.13-0.16 mole % LiF–BeF_2–ZrF_4–UF_4) were measured at 1000 to 1200°C. Extrapolation of the data to the highest MSRE design temperature, 704°C, gave vapor pressures of 0.02 and 0.05 mm, respectively, for the mixtures containing 3.95 and 8.13 mole % ZrF_4. Measurements were begun on the LiF–BeF_2 system in order to obtain thermodynamic activities in this important binary system. Density measurements in the LiF–ThF_4 system yielded molar volumes which were found to be additive, thus further supporting the hypothesis that molar volumes in all fluoride melts may, to a good approximation, be additive. An oscillating cylinder viscometer, which permits observations to be made with the test fluid in a sealed vessel, was constructed for use with molten-salt systems. Preliminary testing with water and with molten NaCl yielded data in good agreement with accepted viscosity values. (auth)

25063 (ORNL-3417(p.51-60)) FLUORIDE SALT PRODUCTION. J. H. Shaffer, F. A. Doss, et al. (Oak Ridge National Lab., Tenn.).

The fluoride production plant, previously operated as two separate batch-processing units, was modified by the addition of a premelting furnace which can deliver molten charges alternatively to both the processing units. A 64% increase in the rate of production may be achieved as a result of this modification. The facility for handling and charging the unmelted raw materials was relocated adjacent to the new premelting furnace and was modified to make use of a vibratory feeder to deliver dry materials into the furnace. All the tubing, valves, gages, and electrical controls for the batch-processing units were replaced to obtain better control of the temperature and of the rate of delivery of gaseous HF during the purification. This replacement will also avoid some possibility of inadvertent contamination of isotopically pure Li^7 compounds with natural Li remaining from previous operations. An enclosed wet sandblasting facility was installed for use in reclaiming salt storage pots and other containers used in molten-salt research. Containers contaminated with Be salts can be cleaned satisfactorily in this facility. The requirements for fuel, coolant, and flush salts for the Molten-Salt Reactor Experiment were anticipated. The necessary Li^7F was ordered from Y-12, Hf-free Zr was purchased in the form of the tetrafluoride, and beryllium fluoride specifications have been established. As a result of cooperative discussions with suppliers of Be, it is believed that material which meets our specifications will soon be available in a competitive market. Laboratory and production processes for removing oxides by treatment with a mixture of H_2 and HF were demonstrated in the purification of the oxide-contaminated salt charge of the Engineering Test Loop. Some 2000 kg of various fluoride salt mixtures were prepared for use by the research and development groups associated with the MSRP and the fuel reprocessing studies of the Chemical Technology Division of ORNL. (auth)

25064 (ORNL-3417(p.61-3)) CHEMISTRY OF PRESSURIZED-WATER REACTOR SYSTEMS. C. F. Baes and T. H. Handley (Oak Ridge National Lab., Tenn.).

In a continuing study of the chemical and radiochemical

behavior of the water in the pressurized-water loop at the Oak Ridge Research Reactor, preliminary results confirmed the effectiveness of natural and synthetic magnetite as a high-temperature ion exchange material for decontaminating the loop water. From 95 to >99% of the Fe, Mn, and Co activities was removed in a single pass through a filter bed of magnetite at 425°F. Radiochemical analyses of the soluble and insoluble portions of the loop coolant gave results which are consistent with a simple hypothesis concerning the mechanism of the transport and deposition of radioactive materials in pressurized-water reactors. (auth)

25065 (ORNL-3417(p.64-8)) CORROSION BY SOLUTIONS. J. C. Griess, J. L. English, et al. (Oak Ridge National Lab., Tenn.).

Studies of the effect of heat flux on the corrosion of Al have continued. Tests were conducted to simulate the decrease in heat flux across the Al fuel element cladding that will occur during an Advanced Test Reactor cycle. The results of these tests indicated that starting fuel element surface temperatures should be 340°F or less if final fuel element temperatures are not to exceed 400°F at the end of a cycle. Other tests showed that heat flux in the range of 1 to 2×10^6 Btu hr^{-1} ft^{-2} was not a significant variable in determining the rate of oxide formation on Al cooled by water at a pH of 5. However, at lower heat flux levels the results indicate that heat flux is an important variable. An attempt is presently being made to correlate all the data obtained at a pH of 5 so that the correlation can be used to predict oxide growth as a function of time and surface temperature in the range of 1 to 2×10^6 Btu hr^{-1} ft^{-2}. In tests conducted for the High Flux Isotope Reactor it was shown that the corrosion of Be by water adjusted to a pH of 5 and at 100°C is independent of velocity in the range of 12.5 to 81 fps. Constant corrosion rates of about 2 mils/yr were observed during tests that lasted as long as 4800 hr. Other tests showed that the electrical coupling of stainless steel to Al in the same environment results in the formation of random deep pits in Al in crevice areas. (auth)

25066 (ORNL-3417(p.69-76)) MECHANISM OF CORROSION OF ZIRCALOY-2. G. H. Jenks, R. J. Davis, and A. L. Bacarella (Oak Ridge National Lab., Tenn.).

As part of the Aqueous Homogeneous Reactor Corrosion Program, experiments were made on the effects of reactor radiations on Zircaloy-2 corrosion in oxygenated solutions of UO_2SO_4 with U depleted of U^{235}, D_2O, and dilute acids at 250 to 300°C. The results of the experiments were reexamined and reevaluated on the basis of presently available information. Significant corrosion effects occurred which could be ascribed to fast-neutron damage. Comparisons of the characteristics of this corrosion with those known for fission-recoil-induced corrosion in UO_2SO_4 solutions, and correlations between radiation damage rates and corrosion rates for neutrons and fission recoils, suggest that the mechanism by which corrosion is affected is the same for the two types of radiations and involves the production of displaced atoms as an initial step. The radiation corrosion in hydrogenated water, tested in one experiment, was significant but probably substantially less than that in the oxygenated solutions. Improvements were made in the impedance-measuring instrumentation. A simple capacitance cell was developed which provides reliable film impedance values; this cell can measure the film impedance on a specimen without interfering with subsequent film impedance or film growth. Two specimens were irradiated in B for two days in the LITR lattice and are presently undergoing postirradiation exposure to 300°C steam plus O_2 with periodic measurements of weight gain and film impedance. Others, irradiated in Cd for four weeks in the ORR lattice, will be in storage until cool enough to handle. Additional experiments on the corrosion of Zircaloy-2 in oxygenated, dilute H_2SO_4 near 300°C were made using the previously developed electrochemical apparatus. It was found that the corrosion during the period from 6 to 300 min after the initiation of exposure conformed to a logarithmic rate law and, in this respect, agreed with previous findings at 208 and 258°C. Considerations of the present results and of data of others for the initial corrosion in some other aqueous environments near 300°C lead to the conclusions that the mechanism of the initial corrosion is the same in each of these environments, and that at a given temperature near 300°C, the value of the most important rate-controlling parameter does not change with change in these aqueous environments. A salt bridge was designed, constructed, and tested for the purpose of performing measurements of the potentials of the Zircaloy-2 electrode with respect to an external calomel reference electrode at 25°C and atmospheric pressure. Equipment was designed, constructed, and tested for determining the capacitance of the corroding electrode. (auth)

25067 (ORNL-3417(p.77-98)) PHYSICAL CHEMISTRY OF HIGH-TEMPERATURE AQUEOUS SYSTEMS. A. S. Quist, H. R. Jolley, et al. (Oak Ridge National Lab., Tenn.).

The electrical conductivities of aqueous potassium sulfate solutions (0.00050, 0.0022, and 0.0050 molal) were measured at pressures up to 4000 bars and at 25 to 800°C. The maximum observed equivalent conductance of K_2SO_4 was 1080 cm^2 ohm^{-1} $equiv^{-1}$, approximately seven times the value of the limiting equivalent conductance at 25°C. The precision of these measurements was estimated to be of the order of ±1%. Phase boundaries of liquid-liquid immiscibility and critical phenomena (where L ≡ V) were determined for the condensed systems $UO_3-CuO-SO_3-D_2O$, $UO_3-NiO-SO_3-D_2O$, and $UO_3-CuO-NiO-SO_3-D_2O$ at temperatures from 280 to 410°C; at SO_3 concentrations varying from 0.02 to 1.0 molal (m); and at varying molal ratios, UO_3 : CuO : NiO. With these results three-dimensional models were constructed which specified the saturating phases or critical phenomena, and the variation in phase boundaries as a function of temperature (260 to 430°C) and composition (0.02 to 1.0 m SO_3), for the four-component systems $UO_3-CuO-SO_3-D_2O$ and $UO_3-NiO-SO_3-D_2O$. Critical surfaces were defined over which maximum molal ratios, Σ(metallic oxide) : SO_3, varying from 0.3 to 0.5 were observed. A glass-to-metal connector was devised by the use of which the effects of pressure on liquid-liquid immiscibility at high temperatures were determined visually. The effect of hydrostatic pressures up to 300 bars in raising the temperature of second-liquid-phase formation in the system $UO_2-SO_4-H_2O$ for solutions varying from 0.14 to 4.5 m in UO_2SO_4 was found to be +0.082°C per bar. This temperature of liquid-liquid immiscibility appeared to show a strong dependency on solvent density. The temperature of heavy-liquid-phase formation from the supercritical fluid $UO_3-SO_3-H_2O$ near 400°C appeared also to show a strong dependency on solvent density. The vapor pressures for the deliquescence of solid UO_2SO_4 hydrate were determined at temperatures from 345 to 425°C. The solubilities of Li_2SO_4 in $H_2SO_4-H_2O$ and in $D_2SO_4-H_2O$ solutions in equilibrium with vapor were determined at 200 to 350°C and at concentrations of free acid from 0 to 1.5 m. Temperatures of critical phenomena (where liquid ≡ vapor) varying between 374 and 470°C were determined visually for solutions of Li_2SO_4,

D_2SO_4, and D_2O at concentrations of SO_3 from 0.02 to 2.5 m and at molal ratios, $m_{Li_2O}: m_{SO_3}$, varying from 0 to ~0.5. Isopiestic ratios with reference to NaCl solutions were determined at 140°C for the chlorides of lithium, potassium, and barium, and for sodium sulfate at concentrations below those previously reported. The data for these salts now extend down to approximately 0.2 m. Plots of isopiestic ratios at constant molality as a function of temperature are approximately linear and, for a given salt, extrapolate to a common value at about 160°C. This behavior suggests the existence of a "critical structural temperature" above which the salt no longer influences the structural character of water. A study of Th(IV) hydrolysis at 94°C in 1 m $NaClO_4$ was completed. Although the equilibria involved appeared to be rapidly reached and reversible, separate ThO_2 solubility results indicated that most of the solutions involved were metastable with respect to the much slower hydrolytic precipitation of ThO_2. From the preliminary results of a study of Th(IV) hydrolysis behavior at 0°C, it appears that sufficient data may soon be available to deduce with confidence the rather complex hydrolysis equilibria involved and their temperature coefficients. (auth)

25068 (ORNL-3417(p.101-10)) COMPATIBILITY OF COATED FUEL PARTICLES AND MATRIX GRAPHITES WITH LIQUID COOLANTS. S. A. Reed, T. H. Mauney, et al. (Oak Ridge National Lab., Tenn.).

Matrices containing coated fuel particles might be attractive as unclad reactor fuel elements in liquid coolants if the systems are adequately compatible. The high thermal conductivity of graphite and the small size of fuel particles indicate that internal temperature gradients should not become excessive at high power densities. Limitations on the rates of heat generation in such fuel elements could, however, occur as a result of other phenomena, such as high rates of heat transfer at the liquid interface. Studies of graphite matrix–water coolant compatibility under high heat flux conditions were inaugurated. Unfueled and fueled ¼-in.-dia. graphite rods were heated internally by electrical resistance in a stream of flowing high-temperature pressurized water. The rod was observed visually by a sight glass arrangement at various levels of heat input. Failures did not occur in fueled or unfueled extruded graphite rods owing to thermal stresses at heat fluxes below 900,000 Btu hr^{-1} ft^{-2}. The linear heat loads of the rods were about 5000 Btu hr^{-1} $in.^{-1}$, far below estimated thermal stress limits. Transverse cracking was observed in some instances at heat fluxes above 1,000,000 Btu hr^{-1} ft^{-2}. However, it was not necessarily due only to the high rates of heat transfer. Rods machined from pyrolytic graphite showed evidence of attack at a linear heat load of 3400 Btu hr^{-1} $in.^{-1}$ (600,000 Btu hr^{-1} ft^{-2}) and splintered at a linear heat load of 4700 Btu hr^{-1} $in.^{-1}$ (860,000 Btu hr^{-1} ft^{-2}). This attack is attributed to thermal stresses between the layers of the weakly bonded laminar pyrolytic graphite. When the heat flux exceeded calculated "burnout" limits on the extruded rods, film boiling occurred and attack of the graphite surface by the steam was observed. The burnout heat flux limits depend on the overpressure and flow velocity of the coolant. By increasing these it was possible to operate at a heat flux exceeding 1,000,000 Btu hr^{-1} ft^{-2} for 12 days without damage to the graphite. No differences in performance were noted between unfueled graphite rods and rods fueled with about 8 vol % of pyrolytic-carbon-coated uranium carbide particles. It is believed that the results of these studies may also be applicable to other liquid coolants.

One of the simplest radiation stability requirements for systems involving liquids, matrix materials, and coated particles is that the system should retain its integrity for a substantial period of time at temperature in the presence of strong gamma radiation. Irradiations have been completed on two autoclave experiments using a 10,000-curie Co^{60} source. In one experiment, balls of four grades of graphite were exposed to liquid and vapor phases of D_2O under He atmosphere at 330°C for 2115 hr, developing a gamma radiation dose of 5.1 whr/g. Very slight swelling and pitting of the graphites were observed, along with very small weight losses. Carbon dioxide and a below-stoichiometric quantity of D_2 were found in the gas. In a second experiment, balls of four grades of graphite were exposed to liquid and vapor phases of Santowax R (mixed terphenyls) under He atmosphere at 400°C for 1770 hr, developing a gamma radiation dose of 4.1 whr/g. Little or no effect on the graphite spheres was noted. The Santowax R had become discolored. Analysis of the gas phase indicated production of methane in rough agreement with the literature, and a quantity of H_2 substantially less than anticipated. The compatibility of coated-particle materials with molten fluoride salts was studied in accelerated tests at 800 to 1000°C in static crucibles under vacuum, or with H_2 or He cover gas. Salt mixtures included LiF–NaF eutectic and LiF–NaF–KF eutectic. Alumina coatings of UO_2 particles, and pure alumina spheres, either dissolved or were cracked in LiF–NaF eutectic at 800 to 1000°C. The attack was more severe under H_2. Pyrolytic-C-coated UC_2 particles were not attacked in this salt at 900°C. Cr appeared to have been transported from vessel walls to the carbonaceous particles at 900°C, possibly by fluoride vapors. (auth)

25069 (ORNL-3417(p.111-13)) RHEOLOGY OF SUSPENSIONS OF THORIA FROM FIRST IN-PILE SLURRY LOOP EXPERIMENT. A. J. Shor and E. L. Compere (Oak Ridge National Lab., Tenn.).

Rheological determinations were conducted on slurries prepared from irradiated thoria drained from the first in-pile slurry loop experiment during and after in-pile operation and recovered from the loop drain tank. Determinations of flow rate at a variety of pressures were made at room temperature in a capillary viscometer on several concentrations of suspensions of the irradiated material and on several concentrations of suspensions of unirradiated batch DT-22 thoria-urania used to load the loop. These measurements were used to calculate the yield stress and coefficient of rigidity according to the Bingham plastic model. The yield stress results were consistent with the anticipated dependence on the cube of volume fraction solids. Although the ratio of yield stress to cube of volume fraction solids, which is an index of flocculation, was higher for the irradiated material, it changed less than in proportion to the inverse square of the particle diameters. This was interpreted as implying that the flocculation properties and yield stress of thoria slurries irradiated to full breeder blanket dose, although increasing with irradiation, might remain within tolerable limits. (auth)

25070 (ORNL-3417(p.114-19)) IN-PILE LOOP STUDIES OF AQUEOUS THORIUM OXIDE SLURRIES. H. G. Savage, E. L. Compere, et al. (Oak Ridge National Lab., Tenn.).

The second in-pile slurry loop experiment was operated in beam hole HN-1 of the Oak Ridge Research Reactor from February 12 to May 15, 1962. It was desired to irradiate a circulating high-temperature aqueous suspen-

sion of pure thoria to produce substantial fissions from in-bred U^{233} and to observe the effects of such exposure on the properties of the slurry. The loop was operated 2036 hr in-pile, in addition to 324 hr of preirradiation testing, receiving a mean neutron flux in the slurry of 1.0×10^{13} nv for 79.4% of this time. Approximately 0.06% of the Th atoms were transmuted and a total of 2×10^{16} fissions per gram of solids was developed. The thoria concentration was ~900 g of Th per liter at 280°C. The ability of the irradiated slurry to be resuspended after a substantial period of settling was demonstrated. No handling problems were encountered with the slurry during operation. Slurry samples taken during the irradiation indicated that the mean particle size changed from 2.3 to 1.5 μ, the x-ray crystallite size from ~2000 to 1000 A, and the surface area from ~1 to 24 m^2/g as the irradiation continued. The run was terminated when electrical leads to the circulating pump were shorted outside the loop containment bulkhead by water leakage. Instead of carrying out a thorough postirradiation examination of the experiment, which did not reach the desired fission dose, a replacement experiment was constructed. (auth)

25071 (ORNL-3417(p.121-9)) SURFACE CHEMISTRY OF AQUEOUS SYSTEMS. C. H. Secoy, F. H. Sweeton, and H. F. Holmes (Oak Ridge National Lab., Tenn.).

The adsorption of HCl on a fused sample of thoria is compared with previously reported data for the adsorption of HNO_3 on thoria of higher surface area. The results from the two cases are in surprisingly good agreement with each other in view of the fact that the fusion of the thoria was expected to reduce the internal surface markedly and thus significantly affect the adsorption capacity. Efforts are in progress to produce, by fusion in a plasma torch, spherical particles with no internal surface. The heats of immersion of several ThO_2 samples in water at 25°C were measured with a sensitive thermistor calorimeter. Specific surface areas of the ThO_2 samples ranged from approximately 1 to 15 m^2/g as measured by N_2 adsorption. Prior to the calorimetric measurements, the samples were outgassed at a pressure of 1×10^{-5} mm Hg for 24 hr at 100 to 500°C. In general, the heat of immersion per unit area increased with increasing outgassing temperature. There was also a unique dependence of the heat of immersion per unit area on the thermal history of the sample prior to outgassing. (auth)

25072 (ORNL-3417(p.130-9)) PHASE-EQUILIBRIUM STUDIES IN THE SYSTEM $UO_2-ThO_2-O_2$. H. A. Friedman, R. E. Thoma, et al. (Oak Ridge National Lab., Tenn.).

Mixtures of U and Th hydroxides containing from 10 to 90% Th were prepared by coprecipitation. These were converted to solid solutions by heating to 1500°C and, in some cases, by subsequent reduction with H_2 at 800°C. Samples of these materials were exposed to air at 200 to 1500°C for periods ranging from 10 hr to 6 months. The results of weight changes, chemical analysis, x-ray-diffraction, electron-diffraction, and metallography were interpreted in terms of the composition-temperature relations of the system at a fixed O_2 partial pressure (that of air). The desirability of testing mixtures of high surface area, which might attain equilibrium rapidly, led to the preparation of high-surface-area, low-bulk-density solid solutions of ThO_2-UO_2 by low-temperature thermal decomposition of the coprecipitated U(IV) and thorium oxalate solid solution. Traces of residual C could be removed only by alternate treatment with O_2 and H_2 at about 1200°C. Such treatment reduced the surface area and increased the bulk density of the material. Efforts to determine the equilibrium partial pressure of O_2 over an equimolar solid solution of ThO_2 and $UO_{2.13}$ gave pressures about 1 order of magnitude higher than those reported for pure $UO_{2.13}$ at 900 to 1200°C. In all cases the gas contained high percentages of CO_2 and CO. Modifications in the apparatus were completed to permit a study of the system at higher temperatures. (auth)

25073 (ORNL-3417(p.143-56)) DIFFUSION PROCESSES. A. P. Malinauskas, E. A. Mason, et al. (Oak Ridge National Lab., Tenn.).

The "dusty-gas" model, previously employed to describe gaseous transport through porous media under conditions of both uniform and nonuniform pressure, was extended to include temperature gradients. In this model the porous medium is visualized as a collection of "dust" particles constrained to remain stationary in space. For binary systems (a single gas and "dust"), the phenomenon of thermal transpiration is accounted for by the model in a consistent way for all aspects which are diffusive in character but, as before, needs modification at high pressures by the addition of an expression to account for the viscous backflow. With this modification an equation is obtained which describes thermal transpiration over the entire pressure range. This equation discloses two new relations not previously noticed: a relation between the maximum in the thermal transpiration curve and the Knudsen minimum in the permeability curve and a relation between the height of the thermal transpiration maximum and the translational heat conductivity of the gas. A feature of the results, as applied to capillary systems, is that the rotational relaxation times in gases can be calculated from the height of the thermal transpiration maxima; this suggests much simpler experimental techniques than those previously employed for the measurement of this phenomenon. Experimentally, results for the diffusion of the gas pair, He and Ar, through a U-impregnated graphite demonstrated that the model could be applied to fueled graphites, while tentative data on a coated graphite specimen showed no deviations from the theoretical expectations because of the different graphite strata constituting the diffusion medium. Insofar as diffusion in the presence of pressure gradients is concerned, the experimental work has come abreast of the theoretical advances, and the behavior of the adjustable parameter required in the theoretical extension to include pressure gradients has been studied. Two additional programs of research were initiated: (1) a set of experiments to test the predictions of the dusty-gas model for the case where a gradient in temperature provides the driving force for transport, and (2) an experimental and theoretical approach to the elucidation of the effect of intermolecular interactions on gas-transport mechanisms. The model was useful in calculations comparing the release of fission gases in ventilated fuel-element configurations that are being considered for use in high-temperature gas-cooled reactors. For example, the calculations showed that fuel elements consisting of a cylindrical fueled matrix enclosed by a gas annulus and a porous sleeve with He flowing through the sleeve to sweep fission gases out of the annulus is approximately 10,000 times more efficient in preventing fission-gas contamination of the coolant than a bare, porous, hollow cylinder with He flowing through the matrix and sweeping fission gases into the central void space to be exhausted. U and Th migration through ceramic matrices is of considerable importance with respect to the design of gas-cooled fuel elements and to an evaluation of anticipated levels of gas-coolant contamination for

a given fuel-element design. Advances in the technology of coating fuel particles and the ability to support coated particles within porous ceramic materials have defined two fuel-migration investigations. These investigations involve U, graphites, and C. One investigation covers U migration within pyrolytic C, which is representative of a fuel coating material; while the second covers U migration in porous graphite, which is representative of a fuel-particle-supporting matrix. In addition, some diffusion experiments were performed on BeO with the ultimate goal of studying fuel-migration phenomena within this material, if it can be shown that BeO represents a stable fuel-element matrix. Experimental work performed in the last year has resulted in the development of several satisfactory techniques applicable to the study of diffusion in ceramic materials at high temperature (1000 to 2000°C). The results reveal that solid-state processes control migration in the dense ceramic materials (such as pyrolytic C and BeO), whereas surface processes appear to control migration in porous materials. The U concentrations in pyrolytic-C specimens were found to be high in contrast to the observed migration rates, which were relatively slow. This situation was completely reversed in the porous graphite specimens. However, all the results reinforce U migration behavior observed in-pile. At present the final set of experiments involving the U–pyrolytic-C systems, and U–porous graphite systems are under way. Experiments involving Th and pyrolytic C were initiated, as well as auxiliary experiments on the self-diffusion of Be in various forms of beryllia. (auth)

25074 (ORNL-3417(p.157-62)) REACTIONS OF GRAPHITE AND PYROLYTIC CARBON WITH GASES. L. G. Overholser, J. P. Blakely, and N. V. Smith (Oak Ridge National Lab., Tenn.).

The rate of reaction of Speer Moderator-2 graphite with a He–CO_2 mixture having a CO_2 concentration of 550 vpm (volume parts per million) was measured at 875, 925, 975, and 1025°C. The rates ranged from 7×10^{-4} to 1×10^{-3} mg of C per gram-hr at 875 and 1025°C respectively. Satisfactory agreement between the reaction rates as determined by weight changes of the specimen and by analyses of the effluent gas for CO was found. Limited data for the reaction rate at a CO_2 concentration of 1100 vpm indicate that the apparent order of the reaction with respect to partial pressure of CO_2 is less than unity in this temperature range. Five lots of pyrolytic-C-coated UC particles (all laminar-type coating) were exposed to partial pressures of steam ranging from 20 to 635 mm Hg at temperatures of 700 to 1100°C. The rate of reaction of the pyrolytic-C coating and the integrity of the coatings were established. Marked differences in the behavior of coatings present on the various lots of particles are attributable, at least in part, to two types of attack by steam, a localized or pitting type and a more general type. The coatings of some of the lots examined appear to be protective at 800°C and below, but rapid failure is indicated at and above 1100°C. The degree of protection afforded the cores by pyrolytic-C coatings at 900 to 1000°C would have to be established experimentally for any particular lot of particles. (auth)

25075 (ORNL-3417(p.163-9)) MEASUREMENT OF TEMPERATURE IN REACTOR ENVIRONMENTS. W. T. Rainey, Jr., R. L. Bennett, and H. L. Hemphill (Oak Ridge National Lab., Tenn.).

Emf error profiles were determined for stainless-steel-sheathed Chromel-P/Alumel thermocouples exposed to H_2 and CO at 870°C. Emf drifts in thermocouples exposed to 7-psig H_2 were found to be caused by changes in the thermal-gradient region of the Chromel leg. Thermocouples exposed to 7-psig CO did not develop appreciable emf error, but showed a region of severe attack of the Chromel wire deep in the furnace and rather widespread attack of the Alumel wire. The sheath showed heavy carbide precipitation. Similar thermocouples exposed to graphite in a flowing stream of purified He and He containing 350 ppm CO at 700°C operated satisfactorily for 5 and 8 months respectively. However, emf error profiles showed that nonhomogeneous regions are developing in thermocouples exposed to both atmospheres. Tests in 7-psig H_2 at 870°C showed large variations in reliability of sheathed thermocouples obtained from different vendors. Screening tests on a large number of thermocouple and sheath materials were carried out in graphite and in Si–SiC–coated graphite with an atmosphere of He containing 500 ppm CO and 500 ppm H_2 at 760 and 982°C. These tests showed that several Ni alloys, Mo, and W were stable (emf error <0.05%) for at least 54 days at 760°C. However, at 982°C, only the Ni–18% Mo and the W were stable within this range. The Si–SiC coating did not affect the errors except for the noble-metal alloys. Tests are continuing. W, W–5% Re, W–26% Re, and Re wires were tested extensively in pure He and He contaminated with CO and O_2. All wires decomposed rapidly at 1200°C in atmospheres containing as little as 10 ppm O_2. Emf output was usually erratic until thermocouple failure occurred. Pure Re appeared to be the most stable material in atmospheres containing CO at temperatures in the range 1150 to 1750°C. W and its alloys developed rapid negative emf drifts at temperatures over 1150°C. The rates of drift were dependent upon temperature and wire size, but they were apparently independent of CO concentration in the range used. W and W–5% Re appeared stable in He containing CO at temperatures below 1150°C. An experiment was designed in cooperation with members of the Reactor Division to determine thermocouple emf errors resulting from composition changes by transmutation in common thermocouple materials. A mockup of the in-pile experimental assembly is presently undergoing out-of-pile thermal cycling tests from room temperature to about 800°C without difficulty. The experiment is designed to allow irradiation of test wires in the F-9 facility of the ORR in a reasonably uniform neutron flux at about 200°C. The assembly will be removed periodically from the reactor and hung on the side of the pool for emf measurements at about 800°C. (auth)

25076 (ORNL-3417(p.170-5)) ALTERNATE COOLANTS FOR GAS-COOLED REACTORS. W. T. Rainey, Jr., R. L. Bennett, et al. (Oak Ridge National Lab., Tenn.).

The following compounds were proposed as possible nuclear-reactor gas coolants solely on the basis of their physical properties: B_2H_6, BF_3, CF_4, MoF_6, MoF_5, NbF_5, NF_3, SF_6, SiF_4, and SiH_4. As the result of a detailed literature survey and thermodynamic calculations, only CF_4, SF_6, and SiF_4 are considered to be promising possibilities. Plans are being made to use Co^{60} irradiation for the initial investigation of the radiolytic stability of these compounds. Decomposition reaction rates will be determined for pure and contaminated gases. The initial emphasis will be on measurement of F_2 generation. Absolute G values, based on chemical dosimetry, will be calculated. The effects of various parameters on the heat transfer properties of dissociating gaseous mixtures at high temperatures were studied. Estimates were made for the thermal conductivity, specific heat, specific volume, and viscosity of He–

$AlCl_3$ and $He-F_2$ mixtures as a function of temperature at various pressures and compositions. Although present technology is not sufficiently advanced to make the use of F_2 practical in a closed cycle at high temperatures, F_2 serves as an excellent example of the effects of dissociation on the thermal properties of a dissociating gas due to its high heat of dissociation and low molecular weight. Under certain conditions a $He-F_2$ mixture has a thermal conductivity and a specific heat considerably greater than the corresponding values for pure He, while the thermal properties and viscosity of a $He-AlCl_3$ mixture are considerably less than those of He. (auth)

25077 (ORNL-3417(p.176-85)) EFFECT OF IRRADIATION ON BERYLLIUM OXIDE. G. W. Keilholtz, J. E. Lee, Jr., and R. E. Moore (Oak Ridge National Lab., Tenn.).

Examination of two irradiated assemblies containing a total of 54 specimens confirmed the severe damage of BeO on exposure to large dosages of fast neutrons. One assembly, containing six large specimens of low-density fine-grain-size material showed serious fracturing of the specimens at neutron dosages from 0.2 to 1.0×10^{21} nvt; the circumferential fracturing in these specimens and the relatively small fast-neutron damage revealed by changes in other properties suggest that thermal stresses contributed markedly to damage in this assembly. In the second assembly, 35 of 48 specimens survived intact at fast-neutron dosages of 1.2 to 3.65×10^{21} nvt and temperatures from 583 to 1100°C. Volume increases of 0.9 to 4.4% occurred in these specimens with hot-pressed specimens expanding more than cold-pressed and sintered specimens under similar conditions. Metallographic examination reveals grain boundary separations, which are more marked in the hot-pressed specimens, and which can account for most of the changes in physical properties observed. Lattice parameter expansion and lattice defect agglomeration both contribute to preferential growth of BeO crystals in the c axis direction; lattice parameter expansion is much reduced in irradiations at higher temperatures but it still appears proportional to neutron dose to 3.6×10^{21} nvt. A suggestion of flux dependence on decrease of thermal conductivity under irradiation was obtained from specimens at the same temperature but at different neutron flux levels. (auth)

25078 (ORNL-3417(p.189-206)) POSTIRRADIATION EXAMINATION OF FUEL MATERIALS. O. Sisman, J. G. Morgan, et al. (Oak Ridge National Lab., Tenn.).

Six stainless-steel-clad UO_2 capsules were irradiated at cladding temperatures of 1300 to 1600°F to burnups of 1000 to 3000 Mwd per metric ton of U in the ORR. These consisted of two instrumented EGCR prototype fuel elements and four tamped and swaged fuel elements. The EGCR prototype tests demonstrated that small strains could cause void formation in the cladding material. The swaged and tamp-packed UO_2 elements were stable under the irradiation test conditions. Several 19-in.-long, ¾-in.-dia. stainless-steel-clad UO_2 fuel elements were irradiated at 1500°F under flowing He at 300 psi. The results of these tests indicated that the cladding was attacked in the loading tube, probably by HNO_3 formed by the action of gamma radiation on N_2 and water. Four capsules of the continuing ETR irradiation series have been examined. These fuel capsules simulate the EGCR fuel elements except for length. Pellets of bulk UO_2 are contained in type 304 stainless steel tubing, 0.75 in. OD and 0.020 in. in wall thickness. Two of these capsules suffered severe cladding failures during irradiation. The reason for these failures was "overpowering" of the experiments combined with nitriding of the cladding. No other evidence of capsule failure was observed, but examination of the two capsules that did not fail has not been completed. Two French-made, thin-walled, stainless-steel-clad UO_2 fuel elements were irradiated at cladding temperatures of 1150°F to burnups of 7500 Mwd per metric ton of U. Postirradiation examination showed excellent fuel element integrity under the irradiation conditions even though two pinhole leaks were observed in one of the capsules. The reason for failure of the cladding is not known. Four more Maritime Reactor fuel-irradiation experiments were examined. Each experiment consisted of a three-rod bundle of rods (0.5 in. in dia. by 18 in. long) which contained low-enrichment UO_2 powder. The rods were fabricated by swaging or vibratory compaction. No changes were apparent in the exterior appearance of the rods except for the presence of a dark oxide film. Changes in dia. and in bowing of the rods were small. About 4% of the Kr^{85} was released from the fuel in ten of the rods; the gas-release values for the other two rods were 10 and 23%. These higher release values were due to higher temperature and/or greater burnup. There was partial sintering of the fuel in several of the rods that were heated to the higher temperatures. One rod contained a central void and exhibited columnar grain growth. Small irradiated fuel plates of UO_2 dispersed in stainless steel were examined. These plates simulate those planned for the core B fuel element of the Enrico Fermi Na-cooled reactor. Examination of two plates irradiated to about 6 at.% U burnup (reported previously) showed very little change. Three other plates, which were irradiated to approximately 25 at.% burnup, were badly swollen, and a fourth was partially melted. Although there were no obvious flaws in the cladding of the swollen plates, significant quantities of fission products had escaped to the Na coolant. Test fuel rods containing vibratory-compacted UO_2-ThO_2 powder were examined as a part of the ORNL Fuel Cycle Program. The type 304 stainless steel tubes are filled with ThO_2–4.5 wt % fully enriched UO_2 at densities of about 85% of theoretical. Both sol-gel oxides and oxides which were fused and then ground were tested. Three rods were examined, and 12 similar rods are being examined. No evidence of significant radiation effects on the rods was found. The fuel burnup in these rods varied from about 3500 to about 20,000 Mwd per metric ton of U + Th. Approximately 2% of the Kr^{85} was released from the fuel in most of the rods. Three types of pyrolytic-C-coated UC particles supplied by three different manufacturers were irradiated in Ta cans in a He atmosphere. The particles were irradiated in four double capsules to about 6 at.% U burnup at 1900 to 2500°F. Some of the capsules suffered air leaks, which caused loss of fission gas and oxidation of the particle coatings. The fission-gas release for good capsules was about 0.1% of that formed. The irradiated particles were leached in HNO_3, and the fraction of particles with cracked coatings was estimated from the U content of the solution. Metallographic examination was used to study the type and extent of particle fracturing, reactions at the core-coating interfaces, and changes in the microstructure of the fuel cores. The duplex coating was found to be the most reliable of the three types tested for protecting the fuel particles and for containing fission gases. Three assemblies were examined in which fueled graphite specimens were irradiated in the MTR. In one of these, a low-permeability graphite can contained four fuel cylinders of uncoated UC_2 particles dispersed in graphite; in the other two experiments, single fuel cylinders of pyrolytic-C-coated fuel particles dispersed in graphite were irradi-

ated in unsealed containers. Maximum fuel temperatures ranged from 2000 to 2800°F, and fuel burnups varied from 1 to 17 at.% U^{235}. The fuel cylinders exhibited good physical stability. Considerable migration of fuel and fission products from the fuel cylinders into the graphite containers was found in all cases. Fuel concentrations in the graphite reached 4% of those in the fuel cylinders. Metallographic examination indicated that fuel-particle structure was affected at U burnups of about 2 at.%. All the particle coatings were broken in one experiment, while about 10% were broken in the other. Three graphite-matrix fuel elements containing pyrolytic-C-coated UC_2 particles were irradiated at 2400°F and burnups to 9 at.% U in the ORR. Results of the postirradiation examination indicated that specimens containing particles with duplex coatings were most resistant to irradiation. (auth)

25079 (ORNL-3417(p.207-16)) FISSION-GAS RELEASE. R. M. Carroll, J. G. Morgan, et al. (Oak Ridge National Lab., Tenn.).

Study of fission-gas release from UO_2 during irradiation was extended to include thin plates of coarse crystals of fused UO_2 and of single crystals of UO_2 as well as sintered compacts. In addition, electrical resistivity of the three types of UO_2 was measured during radiation. Evidence was obtained to show that defects in the UO_2 structure retard the emission of fission gases. Release rates of Xe, Kr, and I_2 were obtained as functions of temperature, specimen structure, stoichiometry, and neutron flux; no combination of direct fission recoil and classical diffusion of fission products in solids accounts for the data. Pyrolytic-C-coated UC particles are being irradiated to determine in-pile fission-gas release rates. UC particles having three different types of coatings, as well as bare UC particles, were irradiated at 1800°F, and burnups up to 30% U. Mechanisms of fission-gas release from each particle type were considered on the basis of the relations of fission-gas release to particle temperature and the ratios of the isotopes released. A postirradiation anneal experiment designed for Kr^{85} release studies is now in operation with sintered UO_2 pellets which were irradiated to high burnups. These studies showed an accelerating release rate with time and the "burst" phenomenon during isothermal operation at 1500°C. (auth)

25080 (ORNL-3417(p.217-18)) RADIATION STABILITY OF CERAMICS. C. D. Bopp, O. Sisman, and R. L. Towns (Oak Ridge National Lab., Tenn.).

Apparatus was developed for thermal analysis of small samples of poorly conducting materials. Calibration by means of Peltier power makes the method quantitative below about 900°C. Irradiation in a reactor causes zircon ceramic to resemble metamict zircon in that subsequent heating to successively higher temperatures may produce some or all of the following: partial annealing of damage, decomposition to zirconia and silica, and re-formation of zircon. (auth)

25081 (ORNL-3417(p.221-32)) RELEASE OF FISSION PRODUCTS ON OUT-OF-PILE MELTING OF REACTOR FUELS. G. W. Parker, W. J. Martin, et al. (Oak Ridge National Lab., Tenn.).

Fission product release data were obtained by use of two new techniques which permit melting of larger amounts of irradiated UO_2 than was previously possible. The two scaled-up procedures gave results that are essentially in agreement and confirm most of the data obtained earlier with milligram amounts of UO_2 irradiated at tracer level. When 30-g quantities of tracer-irradiated UO_2, contained in a W crucible surrounded by a He atmosphere, were melted by use of r-f heating, essentially quantitative release of rare gases and I_2, but somewhat lower releases of Te and Cs were observed. Essentially no Ru or Sr was released. The most apparent explanation of the lower release values observed, as compared with those obtained in earlier, small-scale, experiments, is that the greatly increased volume-to-surface ratio prevailing in the new experiments resulted in a longer diffusion path for the fission products. The lack of O_2 in the He atmosphere also contributed to the reduced Ru volatility. Experiments on a similar scale, in which clad, cored UO_2 pellets surrounding a W resistor were melted, permitted a comparison of the effect of two different metal cladding materials on fission product release. It was found that stainless steel cladding simply segregated and had little effect on release as compared with that observed from unclad UO_2. Molten Zircaloy, however, apparently wet the UO_2 and spread over its surface, producing a 100-fold smaller Te release and a nearly 10-fold increase in Sr release. The molten Zr seems to serve as a getter for excess O_2, causing increased Sr volatility, and as an alloying material with Te. Hot-cell construction is under way to permit the melting of both larger quantities of irradiated UO_2 in W crucibles and the clad UO_2 specimens currently being irradiated. A new ultra-high-frequency generator was tested for use in both programs. (auth)

25082 (ORNL-3417(p.233-5)) RELEASE OF FISSION PRODUCTS ON IN-PILE MELTING OF REACTOR FUELS UNDER TRANSIENT REACTOR CONDITIONS. G. W. Parker and R. A. Lorenz (Oak Ridge National Lab., Tenn.).

A series of experiments on the release of fission products from UO_2 melted under reactor transient conditions will be conducted in the TREAT facility at the NRTS. A program proposal that was reviewed with TREAT management resulted in an agreement on the design of the experimental assembly. The proposed experiments will permit the study of fission product release on melting fully clad, 10%-enriched UO_2 in an Ar-filled autoclave by means of fast transients of varying magnitude. Provision will be made for preheating the samples to 1200°C and for sampling the released gases and smoke promptly by admission through a filter into an evacuated autoclave. The fuel specimens in the first experiments in this facility will not be irradiated prior to melting, but specimens with a high degree of burnup will be melted later. Heat-transfer determinations and leakage testing of the autoclaves have been satisfactorily completed. A hazards analysis is presently being prepared and the first experiment is expected to be inserted in the reactor during the early part of 1963. (auth)

25083 (ORNL-3417(p.236-43)) RELEASE OF FISSION PRODUCTS ON THE IN-PILE MELTING OR BURNING OF REACTOR FUELS. W. E. Browning, Jr., C. E. Miller, Jr., et al. (Oak Ridge National Lab., Tenn.).

Experiments were conducted in the ORR to study the amounts and forms of fission products released during melting of miniature stainless-steel-clad UO_2 fuel elements in a He atmosphere and burning of UC_2-graphite fuel specimens in air. Fission and gamma heat raised the temperature of both types of fuel element high enough to cause their destruction. In the UO_2-melting experiments, nearly all the I_2, Te, and Cs were released from the fuel. Although more than half the Sr, Zr, Ru, Ba, and Ce were released from the fuel, less than 3% of these fission products and of the U were released from the high-temperature

zone. The retention of fission products within the high-temperature zone is considered to be significant since, during an actual reactor accident, temperatures corresponding to those of the high-temperature zone in these experiments would probably occur only in the region immediately surrounding the fuel. Release values obtained in the experiment with UC_2-graphite fuel were lower than those obtained in UO_2-melting experiments for all fission products except Ru, which probably formed a volatile Ru oxide. Analysis of the distribution of fission products on the wall of the tube connecting the UO_2-melting furnace to the filter compartment showed that they were associated with two groups of particle sizes in the millimicron range. The distribution of fission products and of U is being analyzed and interpreted in terms of the fractionation processes which govern the behavior of these materials. (auth)

25084 (ORNL-3417(p.244-50)) CHARACTERIZATION AND CONTROL OF ACCIDENT-RELEASED FISSION PRODUCTS. W. E. Browning, Jr., R. D. Ackley, and M. D. Silverman (Oak Ridge National Lab., Tenn.).

Two methods of determining the form of radioactivity in gases were investigated. Diffusion coefficients of small particles and of radioactive vapors such as I_2 are determined by measuring the distribution of radioactivity on the walls of a channel previously exposed to gas carrying radioactive materials and flowing under laminar conditions. This technique was employed to demonstrate that high-efficiency, low-pressure-drop filters removed about 10 to 75% of the activity from air streams carrying I^{131} adsorbed on 0.004-μ-dia. Al_2O_3 particles. Beds containing a 0.75-in. depth of −6 +16 mesh activated C removed essentially all the I_2 vapor but only 75 to 90% of the 0.003- to 0.006-μ Al_2O_3 particles, the higher efficiency being associated with the finer particles. Fog-condensation and foam-encapsulation methods removed 85 to 99% of these very small particles. The second method of measuring the size of radioactive aerosols makes use of a filter having a uniform fiber diameter to permit theoretical analysis and having a layered structure to facilitate separation of the fiber bed into discrete layers for radioassay after exposure to the aerosol. Preliminary results obtained with a radioactive aerosol of 0.004- to 0.03-μ particles labeled with Zn^{65} indicate that the techniques used are satisfactory. (auth)

25085 (ORNL-3417(p.251-3)) FISSION PRODUCT TRANSPORT EVALUATIONS. C. J. Barton, M. E. Davis, and G. W. Parker (Oak Ridge National Lab., Tenn.).

Two methods of determining the heat of vaporization of radioactive species were tested with I^{131}-labeled I_2 in the search for a technique that can be employed to identify the chemical form of fission products released in simulated reactor accident experiments. One method, which depended on the rate of transfer of I_2 by He flowing at a constant rate, gave values for the heat of vaporization of I_2 ranging from 13 to 15 kcal/mole. The average value, 14.2, agrees reasonably well with the literature value of 14.9 for solid I_2. A completely sealed glass system, consisting of two small bulbs connected by a long capillary tube, comprised the sample container employed in the second method. The change in concentration of I_2 vapor in one bulb which was in equilibrium with solid or liquid I_2 in the other bulb was measured over a range of temperature by means of a crystal detector. Early results obtained by this method varied over a wider range than those obtained by the transport method, but recent data indicate that this may be a useful technique and experiments are in progress to obtain a better understanding of I_2 behavior in this apparatus. Evidences of adsorption of I_2 on glass or quartz walls were observed in both types of experiments. (auth)

25086 (ORNL-3417(p.257-9)) MOLTEN FLUORIDE MIXTURES AS POSSIBLE FUEL REPROCESSING SOLVENTS. R. E. Thoma, H. A. Friedman, et al. (Oak Ridge National Lab., Tenn.).

A preliminary study of the ternary system $LiF-BeF_2-AlF_3$ was made as part of an investigation seeking high-capacity solvents for use in the Fluoride Volatility Process for recovering U from Al-based reactor fuels. The maximum capacity of this solvent at 600°C was ~31 wt % AlF_3. (auth)

25087 (ORNL-3417(p.260-6)) RADIOIODINE-ADSORPTION SYSTEMS FOR THE NS "SAVANNAH." W. E. Browning, Jr., R. E. Adams, and W. M. Johnson (Oak Ridge National Lab., Tenn.).

Studies of the removal of radioiodine from steam-air mixtures continued in support of the NS "Savannah" program. Over 60 small-scale tests and 14 large-scale tests were completed. Activated-charcoal units, prepared in the same manner and using materials similar to those employed in the units installed on the NS "Savannah," were utilized in the large-scale laboratory tests. These tests, conducted with continuous I_2 injection at 96 to 100°C and with 80 to 90% saturated steam in air, showed the efficiency of the charcoal unit to be (99.86 ± 0.07)% at the 95% confidence level. In-place tests of the full-scale filter-adsorber units in the reactor compartment ventilation systems of the NS "Savannah" were conducted with radioactive I^{131} and nonradioactive I^{127}. The emergency ventilation system, containing activated charcoal, exhibits an efficiency generally greater than 99.9%, whereas the main ventilation system, containing no charcoal, showed I_2-retention efficiencies ranging from 90 to 98% in several series of tests. (auth)

25088 (ORNL-3417(p.267-76)) EFFECTS OF RADIATION AND HEAT ON ORGANIC MATERIALS. C. D. Bopp, W. K. Kirkland, et al. (Oak Ridge National Lab., Tenn.).

The acid concentration produced by irradiation of solutions of $C_2H_2Cl_4$ in C_8F_{16} and in $C_{10}H_{22}$ was measured to determine the suitability of these systems as dosimeters. The C_8F_{16} solutions, to which 0.3 wt % $C_{10}H_{22}$ had been added to provide an adequate source of H_2, showed inconsistent acid yields unless water in excess of saturation (0.2 wt %) was present. The $C_{10}H_{22}$ solution showed a dependence on both the temperature and the dose rate during irradiation. The investigation of differences in the effects on polystyrene of gamma radiation and mixed reactor radiation was extended to infrared and gas-chromatographic analyses. Infrared spectrum measurements showed more rapid growth of certain bands in reactor-irradiated specimens than in specimens exposed to gamma radiation alone. The volatile products of gamma irradiation of polystyrene indicated by gas chromatography were H_2 $G(H_2) \approx 1.5 \times 10^{-2}$ molecule per 100 ev, and benzene, $G(C_6H_6) \approx 5 \times 10^{-4}$ molecule per 100 ev. A versatile gamma source comprising a Co^{60} assembly in a 7 × 10 ft shielded compartment was designed for the irradiation of plastics and rubbers during mechanical testing. Pure biphenyl was pyrolyzed at 425°C under such conditions that less than 1% decomposition occurred. The initial primary products were separated in a vacuum system into three fractions having different boiling ranges and analyzed by gas chromatography. A silica-gel column in series with a molecular sieve (Linde 5A) column showed

the presence of H_2, methane, ethane, propylene, ethylene, and propane in the gaseous products, with hydrogen as the major component. Benzene was identified as the lone intermediate-boiling component, using a column of 30 wt % Apiezon L on Chromosorb P. Terphenyl and quaterphenyl isomers comprised the high-boiling or polymeric fraction. They were identified by means of an inorganic salt column, 20 wt % LiCl on Chromosorb P. Quantitative determination of these products suggests that the pyrolytic decomposition of biphenyl proceeds essentially by symmetrical splitting of the biphenyl molecule to form phenyl radicals which either (1) add H_2 to form benzene or (2) react with other biphenyl molecules to produce terphenyls, quaterphenyls, and H_2. (auth)

25089 (ORNL-3417(p.277-9)) CHEMICAL SUPPORT FOR SALINE WATER PROGRAM. W. L. Marshall, E. V. Jones, and E. G. Bohlmann (Oak Ridge National Lab., Tenn.).

The solubility of $CaSO_4$, a major constituent of scale formed in seawater desalination processes, was determined in $H_2SO_4-H_2O$ solutions at temperatures from 125 to 350°C and at concentrations of H_2SO_4 from 0.1 to 1.0 m. The results of preliminary corrosion tests, made with seawater at 100°C in 100-gpm dynamic loops constructed of Ti alloys, indicate the potential usefulness of Al alloys for service in seawater at elevated temperatures. In the absence of impingement, bulk solution velocities of up to 75 fps did not cause accelerated corrosion. (auth)

25090 (ORNL-3417(p.280-2)) CORROSION STUDIES FOR CHEMICAL REPROCESSING PLANTS. J. C. Griess, J. L. English, et al. (Oak Ridge National Lab., Tenn.).

The materials evaluation program for the Transuranium Processing Facility has continued. Tests with Hastelloy C showed it to be generally unacceptable in HCl solutions containing oxidizing agents even at temperatures as low as 35°C. Ta has excellent corrosion resistance in all process solutions, although the problem of H_2 embrittlement was not fully evaluated. Zircaloy-2 was shown to have excellent corrosion resistance in HCl solutions, and, under certain conditions, small amounts of HNO_3 in the HCl did not result in prohibitively high rates. In addition to the tests with metals and alloys, a number of different plastics were shown to be satisfactory in the organic solutions used in various stages of the chemical process. The corrosion program supporting the Chemical Technology Division's development of power-reactor fuel-element reprocessing schemes involved testing many metals and alloys in numerous environments. The greatest number of tests, however, was concerned with the selection of materials for the processing of graphite-bearing fuels and for use in the Chloride Volatility Process. In the associated waste problem, tests were carried out in liquids, and in systems for evaporating liquid wastes to dryness followed by subsequent calcination. In addition, a number of standard acceptance tests were performed on various materials to be used in ORNL and Y-12 projects. (auth)

25091 (ORNL-3417(p.283-4)) CHEMICAL SUPPORT FOR THERMONUCLEAR PROGRAM. J. D. Redman and R. A. Strehlow (Oak Ridge National Lab., Tenn.).

Improvements in the techniques for obtaining high vacuum in large metal systems included studies on composite pumping systems, in which vapor deposition of Ti vapor is supplemented by diffusion pumps, and studies on system design for component testing. Studies of the factors affecting the operation of ionization gages for reading low pressures demonstrated the importance of considering the pumping action by the gage for high-molecular-weight (organic) species. (auth)

25092 (ORNL-3417(p.285-300)) RESEARCH AND DEVELOPMENT ON PURE MATERIALS. C. F. Weaver, R. G. Ross, et al. (Oak Ridge National Lab., Tenn.).

Techniques of growing large (~300-g) single crystals of LiF containing no more than 10 ppm of cation contaminants were developed and employed for the production of several crystals varying in their Li^6/Li^7 isotopic ratio. Four such crystals were produced which were strain-free and in which hydroxyl ions were not detected. Pure crystals of MgO were grown as the primary phase from molten fluoride mixtures at temperatures of ~800°C in thermal convection loops containing molten-salt solvents. The investigation, development, and application of an acetylacetone solvent extraction process, which employs EDTA as a masking agent, for the preparation of high-purity BeO has continued. The distribution of the neutral beryllium acetylacetonate, its aqueous phase formation equilibria, and its aqueous solubility all were found to have a large dependence on aqueous ionic strength. These effects all are in the direction of salting out but are several times larger than is usually encountered. Data now available were used to predict Be extraction behavior as a function of pH, acetylacetone concentration, aqueous pH, and aqueous ionic strength. With adequate agitation, extraction rates were surprisingly rapid in view of the dehydration of the small Be^+ ion which is involved. The losses associated with each step in the purification process were examined; modification of the process and improvements in the equipment were made in order to achieve significantly increased process yields. (auth)

25093 (TID-4005(Pt.2A)) SUMMARIES OF THE USAEC BASIC RESEARCH PROGRAM IN CHEMISTRY (OFF SITE). (Division of Research, AEC). Mar. 1963.

The objective and current status of individual research projects supported by the Office of Chemistry Programs of the Division of Research under its "off-site" program are summarized. The summaries are arranged in the following categories: nuclear chemistry; geo- and cosmochemistry; radiation, photo-, and hot-atom chemistry; isotope effects; high-temperature chemistry; coordination chemistry; general inorganic chemistry; structural and theoretical chemistry; general physical chemistry; physical-organic chemistry; analytical chemistry; and chemical engineering and separations chemistry. (M.C.G.)

25094 THE EXTRACTION OF METAL COMPLEXES WITH ORGANIC ACIDS BY MEANS OF AMINES; THE EXTRACTION OF URANIUM AND TITANIUM COMPLEXES. M. Šušić. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 27-34 (Jan. 1963). (In English)

It is shown that metal complexes with organic acids can be extracted by amines. The investigation of uranium and titanium in ascorbic and oxalic acids showed that their complexes are extracted with benzyl, cyclohexyl, and tri-n-butyl amines in n-butyl alcohol. The extraction increases with an increase in the concentrations of the amine and complexing agent. Oxalate complexes of titanium and uranium and the titanium ascorbic complex are extracted well by tri-iso-octyl amine in xylene, while the uranyl ascorbic complex is not. Preliminary experiments indicate that other elements can be extracted by amines from the solutions of other complexing acids. (auth)

25095 ORGANIC SALTS OF LANTHANIDE ELEMENTS. I. PREPARATION OF TRI-ACYLATES OF LANTHANUM AND CERIUM(III) FROM AQUEOUS SOLUTIONS. S. N. Misra, T. N. Misra, and R. C. Mehrotra

(Gorakhpur Univ., India). J. Inorg. Nucl. Chem., 25: 195-9(Mar. 1963).

Tri-acylates of lanthanum and cerium (III) are quantitatively precipitated by the reaction of their nitrates or chlorides with excess of sodium soaps (laurate, palmitate, stearate) in aqueous solutions. These salts are not hydrolysed by water and are soluble in hot benzene from which pure samples may be crystallized. Molecular weight measurements show them to be monomeric in benzene. Viscosities of their benzene solutions were measured and their thermogravimetric behavior was also investigated. Attempts to prepare mixed chloride or nitrate salts were unsuccessful. (auth)

25096 ORGANIC SALTS OF LANTHANIDE ELEMENTS. II. PREPARATION OF LANTHANUM AND CERIUM(III) ACYLATES FROM A NON-AQUEOUS MEDIUM. S. N. Misra, T. N. Misra, and R. C. Mehrotra (Gorakhpur Univ., India). J. Inorg. Nucl. Chem., 25: 201-3(Mar. 1963).

The reactions of anhydrous lanthanum and cerium (III) chlorides were studied with acetic acid, acetic anhydride-acetic acid, and acetic anhydride. In all three reactions, tri-acetates are the final products in quantitative yield. The molecular weights, determined ebullioscopically in benzene, show them to be monomeric. Reactions of lanthanum and cerium (III) chlorides with palmitic acid were also studied at different molar ratios in benzene and the mono-, di-, and tri-palmitates were isolated. (auth)

25097 APPLICATIONS: THE CONTAMINATION OF CHEMICAL REAGENTS AND MATERIALS. Y. Le Gallic, J. Legrand, and M. Thénard. Bull. Inform. Sci. Tech. (Paris), No. 67, 31-49(Dec. 1962). (In French)

The results of β and γ measurements on numerous chemical reagents and construction materials are shown in tabular and graphic form. The experimental apparatus used is briefly described. (J.S.R.)

25098 THE REDUCTION OF S^{35}-LABELLED SULPHATES. J. Čífka (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Intern. J. Appl. Radiation Isotopes, 14: 174-6(Mar. 1963). (In English)

Kiba's reduction mixture of $SnCl_2$ and H_3PO_4 is used in a wet method for the reduction of S^{35}-labeled sulfates. The released H_2S is absorbed in NaOH solutions. (D.L.C.)

25099 THE PHOTOCHEMISTRY OF METHYLAMINE. Joe V. Michael and W. Albert Noyes, Jr. (Univ. of Rochester, N. Y.). J. Am. Chem. Soc., 85: 1228-33(May 5, 1963).

Hydrogen, methane, nitrogen, ethane, ammonia, ethylenimine, dimethylamine, azomethane, and a polymer were identified as products in the photochemical decomposition of methylamine. Quantum yields of most of these products were determined under a variety of experimental conditions at room temperature. By use of CH_3ND_2 and of CD_3NH_2 as well as by use of scavengers, it was shown that the main primary process is the elimination of a hydrogen atom. This is followed by abstraction from the substrate to form hydrogen gas. Other steps in the mechanism are suggested and evidence for some of them presented. (auth)

25100 DETERMINATION OF THE SOLUBILITY OF WATER IN SOME ORGANIC LIQUIDS BY MEANS OF TRITIUM. J. R. Jones and C. B. Monk (University Coll. of Wales, Aberystwyth). J. Chem. Soc., 2633-5(May 1963).

Tritiated water and liquid scintillation counting were used to obtain the saturation solubilities of water in some aromatic hydrocarbons and halides at 25, 30, and 35°. The results are analyzed in terms of Hildebrand's concepts of solubility parameters and various expressions for calculating entropies of mixing. (auth)

25101 URANIUM(IV) CHLORIDE COMPLEXES OF 1,2-DIMETHYLTHIOETHANE, 1,2-DIMETHOXYETHANE, AND TETRA-P-METHYLETHYLENEDIPHOSPHINE. H. C. E. Mannerskantz (Imperial Coll. of Science and Tech., London), G. W. Parshall, and G. Wilkinson. J. Chem. Soc., 3163-4(May 1963).

Synthesis procedures and properties are reported for the following complexes: UCl_4L_2, where L = 1,2-dimethylthioethane and 1,2-dimethyloxyethane, and UCl_4L, where L = tetra-p-methylethylenediphosphine. (D.L.C.)

25102 COMPLEXES OF THE LANTHANIDE ELEMENTS WITH MERCAPTOCARBOXYLATE LIGANDS. J. L. Bear, G. R. Choppin, and J. V. Quagliano (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem., 25: 513-18(May 1963).

Stability constants were determined by the Bjerrum method for complexes of the α-mercaptopropionate, β-mercaptopropionate, and S-ethylthioglycolate ions with yttrium (III) and several trivalent lanthanide ions. The investigation indicates that the acid anions function as monodentate ligands. (auth)

25103 COMPLEX FORMATION BY N-SUBSTITUTED ACETOACETAMIDES. I. ACID DISSOCIATION CONSTANTS AND STABILITY CONSTANTS OF THE BERYLLIUM COMPLEXES. H. J. Harries (Derby and District Coll. of Tech., Derby, Eng.). J. Inorg. Nucl. Chem., 25: 519-23(May 1963).

A number of derivatives of acetoacetamide were examined as chelating agents. Using the glass electrode, the acid dissociation constants were determined in 50 per cent dioxane (v/v) and the stability constants of their beryllium complexes measured. The variation of pK_a with N-substituent is interpreted in terms of electronic and steric effects. The variation of stability constants shows that the chelating power is related to the basic strength of the enolate ion for a series of structurally similar compounds. (auth)

25104 THE MECHANISM OF EXTRACTION BY TRIBUTYL PHOSPHATE-n-HEXANE SOLVENTS. PART II. NITRIC ACID EXTRACTION. Donald R. Olander (Univ. of California, Berkeley) and Manson Benedict. Nucl. Sci. Eng., 15: 354-65(Apr. 1963).

The kinetics of extraction of nitric acid by tributyl phosphate-n-hexane solvents were investigated in a stirred vessel transfer cell. Elucidation of a possible slow step in the extraction process due to the complexing reaction $HNO_3 + TBP \rightleftharpoons HNO_3 \cdot TBP$ was of particular interest. The criteria used to determine the mechanism were: 1. The effect of temperature. 2. The effect of stirrer speed. 3. Comparison of the mass transfer coefficients to those of nitric acid in a nonreacting solvent. 4. Comparison of the mass transfer coefficients to those predicted by a previously developed correlation for two-component, two-phase systems. On the basis of these criteria, the kinetics were found to be controlled by purely diffusional processes. The mechanism proposed involves mass transfer of the nitric acid through the aqueous film, rapid and complete conversion to the complex at the interface, and transfer of the complex to the organic phase. This last step constitutes the major portion of the over-all resistance, although resistance in the aqueous phase also constitutes a small fraction of the total. No effect of a slow chemical conversion was found. At high acid levels, the transfer process was greatly accelerated (by a factor of 2 to 3) by the phenomenon of

interfacial turbulence, arising probably from the Marangoni effect. (auth)

25105 HEATING AND OPERATIONS AT HIGH TEMPERATURES WITHOUT CONTAMINATION. F. Trombe (CNRS, Paris). Pure Appl. Chem., 5: 591-639(1962). (In French)

A review is given of techniques for maintaining high purity in laboratory and industrial processes that are carried out at high temperatures. Attention is given to: the case in which the crucible containing the substances being studied is in thermal equilibrium with the reactants; the case in which the operations may be carried out using classical heating methods; and the case in which the heating is accomplished by "pure energy" methods (plasma jets, electron torches, etc.). A bibliography of about 100 references is included. (T.F.H.)

25106 KINETIC METHODS IN THE INVESTIGATION OF COORDINATION COMPOUNDS. K. B. Yatsimirskii (Ukrainian Academy of Sciences, Kiev). Pure Appl. Chem., 6: 117-23(1963). (In English)

In order to study the stability of coördination compounds in solutions, it is necessary to determine the equilibrium concentrations of the reactants. The equilibrium concentrations may be determined by means of "indicator reactions" which are catalyzed by the reactants and/or coordination compound. Examples are given of the method. (D.L.C.)

25107 THE UNIMOLECULAR ISOMERIZATION OF METHYLISOCYANIDE AND NONEQUILIBRIUM INVERSE INTERMOLECULAR SECONDARY ISOTOPE EFFECT. Friedemann W. Schneider. Thesis, Seattle, Univ. of Washington, 1962. 214p.

The studies of the isomerization of methylisocyanide, which is considered to be a virtuous example of a unimolecular reaction, have afforded a convincing test of unimolecular rate theories. Various tests for heterogeneity, polymerization and for effects of oxygen and radicals indicated that the isomerization is a clean and homogeneous reaction. Its pressure dependence has been investigated at the temperatures 199.4, 230.4, and 259.8°C from the second to the first order region, and the effect of isotopic substitution has been studied using CD_3NC at 230.4°C over a pressure range of a factor of 10^5. The experimental isotopic ratio k_H/k_D at 230.4°C decreases from 1.05 near p_∞ to 0.37 at 0.1 mm, which corresponds to a factor of 1.45 per D substitution. A new phenomenon characteristic of unimolecular reactions was found: the inverse kinetic isotope effect at pressures in the fall-off region. Activation energies at 6 pressures as well as the "continuous" activation energies from the fall-off showed a decrease with pressure with an activation energy spread of 2.0 kcal/mole for CH_3NC. Fall-off curves and inverse kinetic isotope effect were calculated using the quantum statistical expression of Rice-Ramsperger-Kassel-Marcus with exact harmonic count of energy levels. Good agreement with experiment was obtained. The fundamental frequencies of CD_3NC were calculated according to Wilson's FG matrix method. The effect of anharmonicity was found to be very important. A calculation of anharmonic levels for stretching vibrations and the effect of anharmonicity on the rate constants is discussed. (Dissertation Abstr.)

25108 STUDIES AT HIGH TEMPERATURES: I. CONSTRUCTION AND OPERATION OF PLASMA GENERATORS. II. THE DETERMINATION OF TEMPERATURES AND ELECTRON DENSITIES IN PLASMAS. III. SPECTROSCOPIC INVESTIGATION OF SOME HALIDE REACTIONS IN A PLASMA JET. IV. INVESTIGATION OF EMISSION SPECTRA FROM SULFUR HALIDES IN ELECTRODELESS DISCHARGES. V. THE SILICON TETRAFLUORIDE–SILICON SYSTEM AT HIGH TEMPERATURES. Adli Sadeq Kana'an. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 369p.

Three fluid-stabilized plasma generators were constructed. Two of these were fluid-stabilized with a rod and nozzle-type electrodes. Outer cooling was by water in one and by an inert gas in the other. The cooling fluid, tangentially fed into the arc chamber, formed a vortex around the arc column. By virtue of the vortex centrifugal forces the fluid acted as a coolant and served to constrict the arc. Further constriction was by the self-induced magnetic field manifested in the "pench effect." The third plasma generator was an induction torch where the plasma was produced in a gas, in contact with a susceptor, in the field of a coil, powered from a radio-frequency power supply. Stabilization was by the same vorticity principle. The high temperatures of the plasma jet from the water-constricted arc and electron density in the plasma were determined by the Stark effect broadening of the H_α spectral line. The basic theories of line broadening were reviewed. Temperature and electron density of the plasma jet were determined by the use of the Holtsmark theory and the Griem theory. The electron density and temperature were of the order of 10^{17} electrons per cubic centimeter and about 14,000°K, respectively. Experiments on the plasma were extended to the investigation of spectra from the interaction of the plasma with gases or vapors injected into the jet. Argon and helium plasmas were used to excite a number of carbon and silicon halides (CF_4, CF_3Cl, CCl_4, Teflon, SiF_4, and $SiCl_4$). Emission spectra of the reaction zone were photographed. The combined results of the observations and comparison with spectra from other sources of excitation suggest that the resulting transient species in plasma reactors are highly reactive and their very identity can only be surmised rather than directly proven. An investigation of emission spectra from sulfur halides (SF_6, SF_4, SCl_2, and S_2Cl_2) was made with microwave-excited discharges. The molecular band spectra and atomic spectra were identified and attributed, with certainty, to S_2 and SO molecules and S and Cl atoms. The emission continuum in the region 2,500-2,600 A from SCl_2 and S_2Cl_2 is suspected to be due to molecular species, probably SCl. The transpiration method was used to determine the thermodynamics of the reaction Si(s) + $SiF_4(g) \rightleftharpoons Si_2F_4(g)$ in the temperature range 878 to 1,003°K. The following thermodynamic data were obtained: $\Delta H_{r(935)} = 4.96$ Kcal. mole^{-1}, $\Delta F_{r(935)} = 9.04$ Kcal. mole^{-1}, and $\Delta S_{r(935)} = -4.35$ cal. deg.$^{-1}$ mole^{-1}. The reaction enthalpy and heat of formation of $Si_2F_4(g)$ are estimated as $\Delta H_{r(298.15)} = 6 \pm 2$ Kcal. mole^{-1} and $\Delta H_{f(298.15)}(Si_2F_4) = -375 \pm 3$ Kcal. mole^{-1}. The heat of formation of SiF_2 was also calculated as $\Delta H_{f(298.15)}(SiF_2) = -148 \pm 4$ Kcal. mole^{-1}. (TCO)

25109 METHOD OF MAKING PERMSELECTIVE MEMBRANES. Paul Kollsman. U. S. Patent 3,087,880. Apr. 30, 1963. Filed Apr. 23, 1958.

A method is patented for making a membrane of ion-exchange material, comprising a polyethylene matrix and an ion-exchange compound. After a membrane sheet is formed by combining the polyethylene and the ion-exchange compound under specific conditions of heat and pressure, the sheet is irradiated with x rays. The irradiation produces crosslinking, strengthens and stiffens the membrane, and makes it heat resistant. (M.P.G.)

25110 METHOD OF PRODUCING A PERMANENTLY ACTIVE CATALYST UTILIZING NEUTRON IRRADIATION. Arthur L. Jones, Harold A. Strecker, and Richard F. Firestone (to Standard Oil Co.). U. S. Patent 3,092,588. June 4, 1963. Filed Jan. 8, 1957.

A method is given for introducing a desired type of atom into a lattice of different solids, in order to produce a novel catalyst for hydrocarbon cracking and other catalytic reactions. On specific embodiment of the method comprises forming a mixture of silica, an Al compound, and a B compound, and irradiating the mixture with thermal neutrons to drive the Al into the silica lattice. (D.L.C.)

Analytical Procedures

Refer also to abstracts 24786, 24790, 25536, 25537, 25606, 26202, 26205, 26206, 26208, 26209, and 26210.

25111 (AERE-R-4292) THE ESTIMATION BY PAPER CHROMATOGRAPHY OF NITRO- AND NITRATO-COMPLEXES OF NITROSYLRUTHENIUM IN PROCESS SOLUTIONS. D. Scargill and C. E. Lyon (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1963. 22p.

The parameters affecting the separation of nitrosylruthenium nitrato- and nitro-complexes by paper chromatography were studied, and a comparatively labile species is postulated to account for anomalous behavior. The former paper chromatographic method for the estimation of the proportions of nitro- and nitrato-complexes was found to be sensitive to the precise conditions used. For process solutions containing uranyl nitrate, a modified procedure is given which uses the results from elution with dibutyl cellosolve. This method indicates a higher proportion of nitro-complexes in process solutions than was found previously. (auth)

25112 (AERE-R-4318) THE DETERMINATION OF CAESIUM-137 IN HARWELL EFFLUENT. B. A. Loveridge and A. F. Owens (United Kingdom Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1963. 18p.

Cesium carrier is added to an acidified aliquot of effluent which is passed down a column of ammonium molybdophosphate supported upon silica gel. Sodium hydroxide solution removes the ammonium molybdophosphate while the Cs remains absorbed on the silica gel and is eluted later with hydrochloric acid. The Cs is recovered as $Cs_3Bi_2I_9$. The precipitate is dissolved, reprecipitated as $CsClO_4$, scavenged with $Fe(OH)_3$, again precipitated as $Cs_3Bi_2I_9$ and finally as Cs_2PtCl_6 which is weighed and counted. (auth)

25113 (DPSPU-63-30-6) IMPROVED TECHNIQUES FOR ENVIRONMENTAL SAMPLE ANALYSIS. A. L. Boni (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). June 1963. Contract AT(07-2)-1. 25p.

New methods are described for rapidly processing diverse environmental samples with improved analytical sensitivity and accuracy. Sample concentration is simplified and gamma spectrophotometric analyses are made with a $9\frac{3}{4} \times 9\frac{9}{16}$ in. NaI(Tl) crystal with a $3\frac{1}{4} \times 6$ in. well. Ion exchange columns for the concentration of nuclides in rain, stream, and milk samples are brought directly from field stations, adapted to uniform sample containers, and gamma counted. Column elutrients are analyzed for alpha or beta-emitting nuclides. Dried vegetation is compressed into uniform briquettes, and food products are ashed and dissolved before being inserted into the crystal. Other environmental samples can be counted directly because of the large capacity of the well. Radionuclide concentrations are calculated by an automatic data processing program. Sensitivities were improved over previous methods by factors of 10 to 1000. (auth)

25114 (HASL-134) DETERMINATION OF BERYLLIUM IN URINE BY ION EXCHANGE SEPARATION AND FLUORIMETRIC MEASUREMENT. Doris C. Sutton (New York Operations Office. Health and Safety Lab., AEC). Feb. 1963. 20p.

A method is reported for the determination of Be in 1-liter urine samples. Using Al as carrier, Be is collected as the phosphate. (Ethylenedinitrilo)tetrasodiumacetate (EDTA) is used as masking agent for interfering cations. Al and Be are complexed as fluorides with NaF and are exchanged on the hydroxide form of Dowex 1 x-4 anion resin. Ca, Mg, Fe, and phosphate are not exchanged. The fluoride complexes are removed from the resin by eluting with 6N HCl. The eluate is wet ashed with HNO_3 and H_2SO_4 and Be and Al are collected as hydroxides. Chemical recovery is determined by gamma counting Be^7 tracer. The normal Be is measured fluorimetrically with morin as the reagent. The overall chemical recovery observed with 8 experimental 1-liter samples was $93.5 \pm 4.5\%$. The lower limit of detection for the fluorimetric measurement is 0.005 μg per tube, which is equivalent in the overall method to 0.05 μg/l of urine. (auth)

25115 (LADC-5790) USE AND CALIBRATION OF A GAS CHROMATOGRAPH FOR GAS ANALYSIS AT THE PROJECT ROVER TEST FACILITY. D. H. Liebenberg and F. J. Edeskuty (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 15p.

A gas-chromatograph system operated by test site personnel was used for over a year to monitor the purity of gases used at the Project Rover test facilities at the Nuclear Rocket Development Station. Information was obtained on the efficiency of gas line purges, total impurities of frozen air in a large liquid hydrogen dewar, and the quality of room inerting systems. Daily monitoring of several block and bleed systems, which prevent hydrogen gas from entering a system through a leaky valve, and periodic monitoring of all gas added to the 10^6 cubic feet gas storage bottles are required for safe facilities operation. In addition the chromatograph proved useful in special cases for leak detection in vacuum and high pressure systems. The calibration and operation of the chromatograph system using a column of Linde 5A Molecular Sieve for analysis of H_2, N_2, and O_2 is described. Observations of a thermal conductivity reversal in the binary mixture $He-H_2$ is presented. (auth)

25116 (NASA-TN-D-1597) THE USE OF AN IONIZATION GAGE AS A QUANTITATIVE ANALYZER FOR BI-GASEOUS MIXTURES. Leonard T. Melfi, Jr. and George M. Wood, Jr. (National Aeronautics and Space Administration. Langley Research Center, Langley Station, Hampton, Va.). Dec. 1962. 11p.

The inherent difference in the relative ionization of helium and air was utilized as a means of quantitatively measuring the percentage composition of helium-air mixtures. The technique will find application in facilities requiring multichannel analysis of any bi-gaseous mixtures that have sufficient differences in relative ionization. Upon the completion of laboratory testing, the gas analyzer was successfully field tested in conjunction with a project

in which mixture compositions from 0 to 100-percent helium were measured from a number of survey points in a supersonic stream. (auth)

25117 (ORNL-TM-472) DETERMINATION OF TRACES OF IRON(III) IN NaF–LiF–KF–UF_4 WITH THIOCYANATE. J. C. White (Oak Ridge National Lab., Tenn.). Sept. 20, 1955. Contract [W-7405-eng-26]. 10p.

A direct spectrophotometric determination of iron(III) in NaF–LiF–UF–UF_4 was developed in which the sample is dissolved in H_3PO_4–H_2SO_4–H_3BO_3 solution. Potassium thiocyanate is added to form the iron(III)-thiocyanate complex, which is then extracted with isobutyl alcohol. The phosphoric acid concentration must be maintained above 8 M to prevent reduction of iron(III) by uranium(IV) during dissolution of the sample. The coefficient of variation for the method was 3% for the range of 0.25 to 1.5 mg of iron(III) per gram of sample. (auth)

25118 (PG-Report-251) THE BORON-CURCUMIN COMPLEX IN TRACE BORON DETERMINATIONS. M. R. Heyes and J. Metcalfe (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 16p.

A simple and robust method for the formation of the complex of boron with curcumin is described. The sensitivity of the method is 6.6×10^{-5} $\mu g/cm^2$. Formation of the complex is believed to be quantitative under the conditions used and some evidence is given for a 1 : 3 boron: curcumin ratio. Methods are outlined for the determination of boron in a number of metals, compounds, and organic materials. (auth)

25119 GAS ANALYSIS OF C^{14}-CARBON IN THE FORM OF METHANE. S. Mlinko and T. Szarvas (Central Research Inst. for Chemistry, Hungarian Academy of Sciences, Budapest). Acta Chim. Acad. Sci. Hung., 33: 107-20(1962). (In English)

To avoid the use of expensive and cumbersome vacuum apparatus, a new method was developed in which radioactivity measurements of C^{14}-labeled compounds are made on the C^{14} in the form of methane. Methane is formed by oxidative combustion of the compound and reduction of the resulting CO_2 over a nickel catalyst. The latter reaction is carried out in an excess of H_2 at 350°C, and it was verified that the formation of methane is quantitative under these conditions. The catalyst was prepared by heating nickel nitrate, adsorbed on ignited clay, to 600°C in the presence of O_2 to form nickel oxide. The methane formed is condensed under liquid air. The apparatus for carrying out the procedures is described and illustrated in detail. Experiments carried out on a number of labeled compounds showed that the method gave results within ± 0.3% of those obtained with the conventional CO_2 gas-phase procedure. With the counter used the measurements were independent of the volume of methane counted, volumes equivalent to up to 5 mg carbon being used. Characteristics of the counter used are described. (H.H.D.)

25120 RAPID ENZYME ASSAY TECHNIQUE UTILIZING RADIOACTIVE SUBSTRATE, ION-EXCHANGE PAPER, AND LIQUID SCINTILLATION COUNTING. John R. Sherman (Univ. of Wisconsin, Madison). Anal Biochem., 5: 548-54(June 1963). (In English)

The assay technique consists of determining a labeled anionic product as the radioactivity remaining on anion-exchange paper as measured by direct liquid scintillation counting of the paper after elution of the labeled nonionic substrate from the paper with water. Phosphorylations catalyzed by galactokinase and hexokinase are employed as examples. (auth)

25121 DETERMINATION OF THE CONTENT OF α-EMITTERS WITH SIMILAR ENERGIES IN AN ISOTOPIC MIXTURE. L. S. Gorn and B. I. Khazanov. At. Energ. (USSR), 14: 409-11(Apr. 1963). (In Russian)

Determination of the isotopic concentration by α spectrometry represents an important problem of radiometric analysis; this is made difficult by the fact that the energies of the elements at the start of the U and Th series lie within 4 and 5.7 Mev and determination of the individual lines requires a high resolution. In this respect the small surface and the resulting low efficiency of the best detectors represents a disadvantage. For this reason, an attempt was made to improve the resolution and to increase the sensitivity and the accuracy of the measurements by using α semiconducting devices for analyzing materials containing elements with overlapping lines. Mathematical formulas were derived on the basis of which mixtures, such as U^{238} with E = 4.18 Mev and U^{235} with E = 4.38 Mev could be analyzed, with a resolution of the instruments of 3%. In order to avoid an undue lengthening of the time required for the measurements, a 2-channel, fully transistorized instrument was developed, allowing the separation of more than 2 components under field conditions. The method is suitable for use with α-scintillation instruments, such as CsI(Tl) which have poor energy resolution but high efficiency. (TTT)

25122 THE USE OF GRAPHITE-COATED TUNGSTEN FILAMENTS FOR ISOTOPIC ANALYSIS OF URANIUM BY A MASS SPECTROMETER. I. Opauszky and K. F. Zmbov. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 17-20(Jan. 1963). (In English)

A stable emission of U^+ ions was obtained with graphite-coated tungsten filaments as ion emitters in a single-filament ion source. The isotopic analysis of natural uranium gives an abundance ratio of $U^{238}/U^{235} = 138 \pm 0.18$. (auth)

25123 DETERMINATION OF SOME IMPURITIES IN BERYLLIUM BY NEUTRON ACTIVATION. Jean Laverlochère (CEN, Grenoble, France) and Serge May. Bull. Soc. Chim. France, No. 3, 457-62(Mar. 1963). (In French)

Activation analysis is used to determine trace impurities in beryllium acetate and metallic beryllium by measuring the average and long-lived radioisotopes formed by neutron irradiation in a flux of $\sim 5 \times 10^{12}$ $n/cm^2/sec$. Some elements are measured in a nondestructive manner (Mn, Cu, and Na), whereas for others chemical separations are necessary (rare earths, Cr, Sc, Fe, Co, Zn, Ta, and Ni). All the measurements are made by gamma spectrometry. The sensitivity limits obtained lie between 5×10^{-10} and $\sim 5 \times 10^{-6}$ g according to the element. (tr-auth)

25124 SPECTROCHEMICAL ANALYSIS OF RADIOACTIVE MATERIALS. II. WALL-STABILIZED ARC DISCHARGE. Vratislav Svoboda (Research Inst. for Detection and Application of Radioisotopes, Prague). Chem. Anal. (Warsaw), 7: 181-5(1962).

Attempts were made to improve the reproducibility of the arc discharge method for the analysis of radioactive materials and to evaluate the advantages or disadvantages so achieved. Construction of the discharge chamber is described and illustrated. Discharge space stability was followed with a continuously recording camera. The discharge space stabilization improved the discharge duration reproducibility in single half-periods. With a free-burning arc between clean graphite electrodes the burning duration in half-periods varied from 3 to 6 msec; however, burning duration of stabilized arc varied from 4 to 5 msec. The highest stability was achieved by the complete closing of

the oxygen inlet during the discharge. Discharge temperature was shown to depend on ionization potential of the sample in the same way as with the free burning discharge. The change of the dependence exceeds only slightly the error of measurement. The observed greater influence of ionization potential of the evaporated material on the temperature of the stabilized arc may be explained by the presumably higher concentration in the walled discharge space. Comparative determination of Mn, Y, Co, La, Ca, and In with the free-burning discharge and stabilized arc showed that the stabilized discharge results were much more reproducible and in some cases (Co, La, Y) more sensitive than with the free-burning discharge. (TCO)

25125 DETERMINATION OF SMALL AMOUNTS OF THALLIUM BY ISOTOPE DILUTION METHOD. Jerzy Minczewski and Cezary Rozychi (Technical Univ., Warsaw). Chem. Anal. (Warsaw), 8: 63-70(1963). (In Polish)

A method of extracting Tl, labeled with Tl^{204} of a known activity, was developed. It consists of extraction by chloroform solution of dithizone from solutions containing sodium hydroxide, sodium potassium tartrate, and potassium cyanide. Thallium is stripped from the chloroform solution of dithizonates with triple distilled water. From the aqueous solution Tl is repeatedly extracted as Tl dithizonate, which is in turn decomposed with acetic acid. The dithizone solution obtained is determined colorimetrically. After determination of acetic acid solution activity, the total amount of Tl is calculated by the isotope dilution. It was found that Pb^{2+}, Cd^{2+}, Zn^{2+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Hg^{2+}, Bi^{3+}, Ag^{+}, and Cu^{2+} do not interfere. The method was used for the determination of Tl in chamber dusts. (auth)

25126 APPLICATION OF XYLENOL ORANGE TO SPECTROPHOTOMETRIC DETERMINATION OF RARE EARTHS. Danuta Prajsnar (Silesian Technical Univ., Gliwice, Poland). Chem. Anal. (Warsaw), 8: 71-4(1963). (In Polish)

Xylenol orange was applied as a complexing agent for the spectrophotometric determination of the sum of rare earths or individual elements of the group, after their separation. The influence of wave length, pH and rare earth concentration on the absorption was investigated. The rare earth complexes with xylenol orange obey the Lambert-Beer's Law at $\lambda = 576$ mμ in the concentration range 0.5 to 4.0 μg/ml. (auth)

25127 REVIEW OF ANALYTICAL METHODS FOR DETERMINATION OF RARE EARTHS. [PART] I. Teresa Nowicka-Jankowska and Zofia Radwan (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Chem. Anal. (Warsaw), 8: 127-50(1963). (In Polish)

A review is given on the separation of rare earths by chromatography, electrophoresis, extraction, and electrolysis in various materials, such as ashes, ores, minerals, and metals. Types of spectrographs and generators that could be used in various problems of analysis, and the possibilities of applications for solving some problems of analysis of rare earths are also reported. (P.C.H.)

25128 TRACE DETERMINATION BY ACTIVATING ANALYSIS. J. Hoste (Rijksuniversiteit, Ghent). Chem. Weekblad, 58: No. 10, 106-11(1962). (In Dutch)

The principles and techniques of trace determination by activation analysis are briefly reviewed. The sources of error in this quantitative analytical method are summarized. Activation using charged particles and photons is also discussed. Utilization in metallurgy and semiconductors, in geochemistry, and in biochemistry and medicine is briefly reviewed. (J.S.R.)

25129 MEASUREMENT OF ARGON-41 CONCENTRATION IN EFFLUENT GAS. Roger C. Brown (Washington State Univ., Pullman). Health Phys., 9: 315-18(Mar. 1963). (In English)

A gaseous effluent monitoring system using a G-M tube as a detector was constructed and calibrated to determine the concentration of Argon-41 in the effluent gas from Washington State University's 100 KW research reactor building. The system consists of a G-M tube detector located directly in the effluent stream, a rate meter, a high voltage supply and a strip chart recorder. A 2 by 2-in. NaI crystal and gamma ray spectrometer were used to calibrate the system. Results of calibrations at different concentrations of Argon-41 indicated a linear relationship between the concentrations of Argon-41 and the response of the G-M detector. This detector indicates 2.9×10^{8} counts per min for each μc/ml. of Argon-41 concentration. This system provides over ten counts per min above background (background ~67 counts per min) at the maximum concentration of 4×10^{-8} μc/ml. specified in Section 20.106 and Appendix B of 10CFR20 for unrestricted release of Argon-41 in gaseous effluents. (auth)

25130 ISOTOPE DILUTION ANALYSIS OF AMINO-ACIDS. PART I. A CHECK ON THE ABSENCE OF RACEMISATION DURING BENZYLOXYCARBONYLATION. W. R. Waterfield (Radiochemical Center, Amersham, Bucks, Eng.). J. Chem. Soc., 2731-6(May 1963).

Reverse isotope dilution analysis is shown to provide a convenient method for determining the optical purity of L-amino acids. Use of this technique confirmed the absence of racemization during acylation of nine monobasic amino acids with benzyloxycarbonyl chlorides. The preparation of several 4-bromobenzyloxycarbonyl derivatives is described. (auth)

25131 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM AND THORIUM USING NORWOGONIN. Mohan Katyal and R. P. Singh (Delhi Univ., India). J. Indian Chem. Soc., 40: 191-4(Mar. 1963). (In English)

Uranium(VI) and thorium(IV) form orange-colored complexes with norwogonin (5,7,8-trihydroxyflavone) that are soluble in aqueous ethanol. The use of the reagent for spectrophotometric determination of U and Th has been investigated. Beer's law is obeyed over the range of 4 to 20 ppm of metal ion. The Th complex is stable between pH 2.7 and 3.9 and that of U between pH 2.7 and 5.0. Solutions of the Th complex become opalescent at or above pH 3.6 on keeping for a few hours. The molar compositions of the complexes formed by U and Th were found to be 1:2 and 1:1, respectively. (auth)

25132 MASS SPECTROMETRIC DETERMINATION OF DEUTERIUM IN HELIUM. P. Baertschi and F. Stuber (Eidgenossischen Institut fur Reaktorforschung, Würenlingen, Switzerland). Nukleonik, 5: 86-7(Feb. 1963). (In German)

For the determination of D_2 in mass number-equivalent He, D_2 was determined by mass spectrometry as mass number 3 by admixtures of H_2 and equilibration to HD. A simple method is described, and its utility was shown experimentally. (tr-auth)

25133 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM AND OTHER COLOUR REACTIONS BY GALANGIN. Mohan Katyal and R. P. Singh (Univ. of Delhi). Proc. Indian Acad. Sci., Sect. A, 57: 259-65(Apr. 1963).

A spectrophotometric method, based on the formation of a yellow colored complex between Zr and galangin, is described for the determination of Zr. Maximum absorption

by the reaction product only at one specific wavelength (410 mμ) in the acidity range of 0.5N-HCl to pH 4.5, suggests the formation of only one complex. The complex, not extractable by usual organic solvents, was studied in 40% alcoholic medium. It obeys Beer's law from 1 to 6 ppm of metal ion concentration and contains the two components in the molar ratio of 1:1. The effect of the reagent on other ions was studied qualitatively. Also, the effect of foreign ions on the complex was also investigated. (P.C.H.)

25134 NEUTRON ACTIVATION ANALYSIS OF FLUID INCLUSIONS FOR COPPER, MANGANESE, AND ZINC. Gerald K. Czamanske (Massachusetts Inst. of Tech., Cambridge), Edwin Roedder, and Forest C. Burns. Science, 140: 401-3(Apr. 26, 1963).

Microgram quantities of Cu, Mn, and Zn, corresponding to concentrations greater than 100 ppm, were found in milligram quantities of primary inclusion fluid extracted from samples of quartz and fluorite from two types of ore deposits. The results indicate that neutron activation is a useful analytical method for studying the content of heavy metal in fluid inclusions. (auth)

25135 DETERMINATION OF CATION EXCHANGE CAPACITY IN COLLOIDAL SOIL MATERIAL BY MEANS OF RADIOSTRONTIUM (Sr^{89}). H. Bergseth, F. A. Hageboe, H. Lien, and K. Steenberg (Agricultural Coll. of Norway, Vollebekk). Soil Sci., 95: 97-100(Feb. 1963).

An isotope method for the determination of cation exchange capacity (C.E.C.) in colloid soil material by means of Sr^{89} is described. Results are reported on four different types of soil material, and comparisons are made between the isotope method and a flamephotometric determination of absorbed strontium. The effect on the observed C.E.C. values when $CaCO_3$ is added to the samples was studied for the isotope method. (auth)

25136 THEORY AND APPLICATION OF NEUTRON SCATTERING IN THE MEASUREMENT OF SOIL MOISTURE. J. Roger McHenry (Dept. of Agriculture, Oxford, Miss.). Soil Sci., 95: 294-307(May 1963).

The determination of soil moisture by the neutron-scatter technique is considered in a theoretical discussion. Calculated and measured neutron fluxes are considered in various systems of concern to the technician desirous of improving techniques of measuring soil moisture. Differences in the response of a Nuclear-Chicago P-19 and a Troxler Model 102 neutron probe are presented. (auth)

25137 EXTRACTION OF THE CUPFERRON COMPLEX OF NIOBIUM. James F. Reed (Westinghouse Central Labs., Pittsburgh). Talanta, 10: 347-50(Apr. 1963). (In English)

The precipitation of the cupferron complex of niobium is well known, but the literature states that the extraction of the complex with an organic solvent is either not quantitative or suitable for separating only milligram amounts of niobium. It is shown that under suitable conditions in sulfuric acid solution, chloroform extraction of the cupferron complex of niobium can be made quantitative. Less than 0.05% of the niobium remains in the acid layer. Nonextracted elements may be determined by any standard method. (auth)

25138 ISOTOPIC DILUTION ANALYSIS BY SOLVENT EXTRACTION. V. DETERMINATION OF TRACES OF IRON. JiŘí Starý, Jaromír Růžička, and Milan Salamon (Charles Univ., Prague). Talanta, 10: 375-81(Apr. 1963). (In English)

Iron is determined with cupferron in amounts of 10^{-7} to 10^{-9} g/ml with an average precision of ±4.3% and in amounts of 10^{-10} g/ml with an average precision of ±8.3%. The sensitivity of the method might be further increased by using carrier-free radioiron. The method is very simple and rapid, consisting of a single extraction of the analyzed solution and measurement of the activity of the extract. The procedure is far more sensitive and precise than other methods of trace analysis. Errors arising from traces of iron present in reagents and vessels are avoided by careful purification. (auth)

25139 APPLICATION OF CONSTANT CURRENT POTENTIAL LIMIT COULOMETRY TO CHEMICAL ANALYSIS. I. J. McColm, V. M. Sinclair, and R. S. Roche (United Kingdom Atomic Energy Authority, Caithness, Scotland). Talanta, 10: 387-97(Apr. 1963). (In English)

Constant current potential limit coulometry is examined as an alternative to controlled potential coulometry. It is shown that the accuracy and precision obtainable by this new technique compare favorably with those obtained by controlled potential coulometry. Data are presented on its use in the determination of uranium(VI), cadmium(II), and copper(II) using various base electrolytes. The study of uranium was extended to cover the presence of various impurities. (auth)

25140 DETERMINATION OF COPPER IN HIGH-PURITY NIOBIUM, TANTALUM, MOLYBDENUM AND TUNGSTEN METALS WITH BATHOCUPROÏNE. Elsie M. Penner and W. R. Inman (Dept. of Mines and Technical Surveys, Ottawa). Talanta, 10: 407-12(Apr. 1963). (In English)

A spectrophotometric method for determining 0.0005 to 0.125% of copper in high-purity niobium, tantalum, molybdenum, and tungsten metals is described. After sample dissolution and reduction of copper to the univalent state with ascorbic acid, the yellow complex formed by copper(I) and bathocuproine (2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline) is extracted into n-amyl alcohol and the absorbance of the resulting extract is determined at 476 mμ. Other impurities present in the four high-purity metals described do not interfere in the proposed method. (auth)

25141 DETERMINATION OF CERIUM ADMIXTURES IN ALLOYED STEEL. A. B. Gurevich, O. M. Kirzhner, N. I. Sandler, and V. N. Murav'ev (Ukrainian Research Inst. of Metals, USSR). Zavodsk. Lab., 29: 283-6(1963). (In Russian)

It was found that sulfide admixtures of Ce are easily dissolved in diluted hydrochloric acid and are stable in iodine. The data are used in the analysis of steel containing 0.05 to 0.12% C, 0.60% Mn, 0.20 to 0.40% C and 0.03% S. (tr-auth)

25142 SPECTRAL ANALYSIS OF STEEL AND RARE EARTH ALLOYS. N. N. Sorokina and V. M. Golubeva (Bardin Central Research Inst. of Ferrous Metallurgy, USSR). Zavodsk. Lab., 29: 559-60(1963). (In Russian)

Direct spectral analysis of pure steel and steel alloyed by Ce, La, Nd, and Pr showed that rare earth determination sensitivity is higher in argon medium and when the specimen has negative polarity. The relative order of accuracy is 12 to 15%. (tr-auth)

25143 STUDY OF THE REACTION OF PLUTONIUM (IV) WITH ARSENAZO III. A. A. Nemodruk and N. E. Kochetkova. Zh. Analit. Khim., 18: 333-8(Mar. 1963). (In Russian)

Two series of complexes are formed by the interaction of plutonium(IV) with arsenazo III depending on the concentration of nitric acid. At the low nitric acid concentration

(~0.1N) complexes with plutonium/arsenazo III ratios of 1:1 and 1:2 are formed, whereas in solutions of high acidity (4 to 7 N) the ratios are 1:1, 1:2, and 1:3. Optimum conditions for the photometric determination of Pu are not less than the three-fold excess of arsenazo III and the concentration of nitric acid of 4 to 7 N. The molar extinction coefficient of the complex (with the component ratio of 1:3) formed under these conditions is 136000. (auth)

25144 HYDROXAMIC ACIDS AS ANALYTICAL REAGENTS. COMMUNICATION I. SPECTROPHOTOMETRIC STUDY OF THE REACTION OF TITANIUM WITH BENZOHYDROXAMIC ACID. I. P. Alimarin, N. P. Borzenkova, and R. I. Shmatko (Moscow State Univ.). Zh. Analit. Khim., 18: 342-7(Mar. 1963). (In Russian)

A study was made of the interaction of Ti with benzohydroxamic acid in aqueous solutions, and the effect of various factors on the optical density of solutions of the compound formed was determined. The dissociation constant of the reagent was determined by potentiometric and spectrophotometric methods. Optimum conditions for the formation of a soluble colored Ti–reagent complex were found, and it is shown that the complex may be used for the photometric determination of Ti. The sensitivity of the determination is 1.2×10^{-7} g/ml of Ti. (auth)

25145 DETERMINATION OF COPPER, LEAD, CADMIUM AND ZINC IMPURITIES IN INDIUM OF SPECIAL PURITY AND ITS SALTS BY THE METHOD OF AMALGAM POLAROGRAPHY WITH A STATIONARY ELECTRODE. S. I. Sinyakova, A. G. Dudareva, I. V. Markova, and I. N. Talalaeva (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow and Inst. of Fine Chemical Tech., Moscow). Zh. Analit. Khim., 18: 377-84(Mar. 1963). (In Russian)

A method of amalgam polarography with a stationary electrode (a Hg drop) was developed for the determination of Zn, Cd, Pb, and Cu impurities in metallic In and its salts at their concentration down to 10^{-6}%. The method is based on In extraction (as bromide) with diisopropyl ether from a 5 M solution of hydrobromic acid followed by the determination of Zn, Cd, Pb, and Cu by the curves of anodic dissolution of the metals from the amalgam at a continuously changing potential, after their concentration in the Hg drop at a certain potential in K (Na) hydroxide and HCl solutions. The maximum experimental error of the determination of impurities is ±15%. The necessary number of extractions with diisopropyl ether depending on the In sample weight was established. The effect of complexone III, sodium acetate, and sodium tartrate on the shift of the In wave towards more negative potentials was studied by the method of oscillographic polarography. The results of the analysis of certain In samples are given showing their good reproducibility. (auth)

25146 PHOTOMETRIC-DETERMINATION OF CERIUM IN ALUMINUM OXIDE METHANOL SUSPENSION. N. G. Mendlina. Zh. Analit. Khim., 18: 408-9(Mar. 1963). (In Russian)

A citrate-peroxide photometric method was used for the determination of Ce in an aluminium oxide–methanol suspension. The time required for the analysis of the liquid phase is 20 to 30 min. (auth)

25147 COMPLEXONOMETRIC DETERMINATION OF RARE EARTHS IN THE PRESENCE OF DIALKYLPHOSPHORIC ACIDS. Z. A. Sheka and E. I. Sinyavskaya (Inst. of General and Inorganic Chemistry, Kiev). Zh. Analit. Khim., 18: 460-2(Apr. 1963). (In Russian)

A method was established for determining La and rare earths in their compounds with dialkyl-ortho-phosphoric acids by the method of complexonometric titration with xylenol orange. (auth)

25148 SPECTROPHOTOMETRIC STUDY OF PEROXIDE CERIUM COMPLEXES. V. N. Tikhonov and V. N. Podchainova (Kirov Ural Polytechnical Inst., Sverdlovsk, USSR). Zh. Analit. Khim., 18: 463-7(Apr. 1963). (In Russian)

A comparative study was made of the absorption spectra of colored peroxide Ce complexes in pure solutions and in the presence of other rare earths and Mg. The spectrum regions are shown where optical density should be measured when Ce is determined by the peroxide method. (auth)

25149 QUANTITATIVE SEPARATION OF THORIUM AND TITANIUM BY AN ION EXCHANGE CHROMATOGRAPHIC METHOD. I. P. Alimarin, A. M. Medvedeva, and M. A. Burlova (Inst. of Fine Chemical Tech., Moscow). Zh. Analit. Khim., 18: 468-73(Apr. 1963). (In Russian)

A study was made of the possibility of separating Th from Ti by an ion exchange chromatographic method in the presence of H_2O_2 and HCl. It was established that Th is quantitatively sorbed on a cationite in the presence of 3 to 4 N HCl and H_2O_2, whereas Ti goes into the filtrate as a yellow complex $[TiO(H_2O_2)]^{2+}$. Various eluents for Th extraction from the ion exchange resin were tested, and it was established that Th may be completely desorbed with ammonium oxalate, practically at any concentration (above 0.1M). It was shown that Th desorption with ammonium oxalate goes on owing to the formation of a complex ion $[Th(C_2O_4)_3]^{2-}$. (auth)

25150 TO THE QUESTION OF OXIDIMETRIC DETERMINATION OF NIOBIUM IN COMPLEX CARBIDE MIXTURES. E. E. Kotlyar and T. N. Nazarchuk (Inst. of Metalloceramics and Special Alloys, Kiev). Zh. Analit. Khim., 18: 474-9(Apr. 1963). (In Russian)

A study was made of Nb reduction with Al powder, Zn dust, Zn amalgam, metallic Cd, and in a Cd reducer at various acidity of the solution. Conditions were found for Nb reduction to a valency of 3. On the basis of the data obtained, an oxidimetric method was developed for Nb determination in Nb carbide and complex carbide mixtures of the NbC–ZrC type. (auth)

25151 PHOTOMETRIC STUDY OF THE INTERACTION OF URANIUM(IV) WITH ARSENAZO III. A. A. Nemodruk and P. N. Palei. Zh. Analit. Khim., 18: 480-5 (Apr. 1963). (In Russian)

The interaction of uranium(IV) with arsenazo III in HCl solutions was studied by a photometric method. It is shown that U(IV) reacts with arsenazo III forming two series of complexes depending on the HCl concentration. The complexes are quite different in their optical characteristics. In about 0.1M HCl solutions complexes with the U/arsenazo III ratio equal to 1:1 and 1:2, and in 6 to 8M HCl solutions complexes with the U/arsenazo III ratio equal to 1:1, 1:2, and 1:3 are formed. The photometric determination of U(IV) with arsenazo III is the most sensitive (the molar extinction coefficient at 665 mμ is 127000) when the HCl concentration is 6 to 8M, and the amount of arsenazo III is not less than 3 times as much as the amount of U present. (auth)

25152 STUDY OF THE LUMINESCENCE OF URANYL SULPHATE AND URANYL FLUORIDE SOLUTIONS FOR INCREASING THE SENSITIVITY OF URANIUM DETERMINATION. T. S. Dobrolyubskaya (Vernadskii Inst. of

Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 18: 486-91(Apr. 1963). (In Russian)

In studying the uranium(VI) luminescence in solutions containing fluorides and sulfates the possibilities were found of using luminescence, when it is excited by the light with the wave length of 253.7 mμ, for quantitative U determinations. It was established that the intensity of the U(VI) luminescence and, consequently, the sensitivity of its determinations in solutions containing fluorides and sulfates increase when sodium trimetaphosphate is introduced into the solution. As there are certain relations for uranyl fluoride and uranyl sulfate solutions between the luminescence intensity and the U(VI) concentration, the amount of fluorine ions (corresponding to sulfate ions), and the temperature, it is possible to use as reference only such solutions that have the U concentration, salt composition, and temperature similar to those of the analyzed solutions. (auth)

25153 THERMOGRAVIMETRY IN ANALYTICAL CHEMISTRY. COMMUNICATION 4. THERMOGRAVIMETRIC STUDY OF PLUTONIUM(IV) IODATE. I. S. Sklyarenko and T. M. Chubukova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 18: 492-5(Apr. 1963). (In Russian)

It was shown that anhydrous plutonium iodate, $Pu(IO_3)_4$, is formed in the temperature range 150 to 250°C and that it can be used as a weighing form with a more favorable conversion factor in comparison with PuO_2 if KIO_3 is completely washed out of the $Pu(IO_3)_4$ precipitate. When an excess of KIO_3 is present in $Pu(IO_3)_4$, PuO_2 reaches its theoretical weight at a temperature above 850°C. It was found that thermal decomposition of $Pu(IO_3)_4$ goes on through the formation of $Pu(IO)_2(IO_3)_2$. This compound is satisfactorily stable in the interval of 350 to 450°C and is not hygroscopic in air. (auth)

25154 SPECTROGRAPHIC ANALYSIS OF ALUMINIUM OF HIGH PURITY. O. E. Degtyareva, L. G. Sinitsyna, and A. E. Proskuryakova. Zh. Analit. Khim., 18: 510-13(Apr. 1963). (In Russian)

A method is suggested for the direct simultaneous determination of 34 elements (B, P, Zn, Cd, Sb, Be, As, Co, W, Si, Mn, Fe, Mg, Pb, Ga, Ni, Bi, V, Mo, Sn, Ti, Cu, In, Ag, Pt, Pd, Ca, Cr, Ba, Tl, Na, K, Li, Rb) in aluminium oxide by means of fractional distillation from carbon electrodes into a d-c arc at 7 to 12 amp. The spectra are recorded on spectrographs. The sensitivity of the determination is 3×10^{-5} to 3×10^{-2}% and reproducibility is of 10 to 20%. A study was also made of the effect of the density of the Al_2O_3 powder on mixing during the preparation of standards. (auth)

25155 SEPARATION OF TIN AND STIBIUM FROM INDIUM BY EXTRACTION WITH N-BENZOYLPHENYLHYDROXYLAMINE. E. E. Rakovskii and O. M. Petrykhin (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 18: 539-41(Apr. 1963). (In Russian)

The extraction of Sn(IV), Sb(III), and In N-benzoylphenylhydroxylaminates from HCl and H_2SO_4 solutions was studied. The separation of In from large amounts of Sb and Sn was carried out by the extraction of Sn(IV) and Sb(III) from a 10 N H_2SO_4 solution. The extraction of Sb sulfate with chloroform from a concentrated H_2SO_4 solution was also observed. (auth)

25156 ON THE INTERACTION OF THORIUM WITH SODIUM HEXAMETHYLENEDIAMINETETRA-ACETATE. D. I. Ryabchikov, M. P. Volynets, and V. A. Zarinskii (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 18: 542-4(Apr. 1963). (In Russian)

It was established thermogravimetrically, by high-frequency titration, and by a chemical method that the composition of a sparingly soluble complex compound of Th with sodium hexamethylenediaminetetraacetate obtained from a Th nitrate solution at pH 3 corresponds to a formula $ThHA \cdot 3H_2O$. It is shown that sodium hexamethylenediaminetetraacetate may be used for Th determination in the presence of five times as much rare earth. The end point of titration is established by a high-frequency method. (auth)

25157 USE OF FORMAZANS IN ANALYTICAL CHEMISTRY. COMMUNICATION 3. N,N′-DI-(2-HYDROXY-5-SULPHOPHENYL)-C-CYANFORMAZAN — A NEW REAGENT FOR ZIRCONIUM DETERMINATION. N. L. Vasil'eva and M. I. Ermakova (Inst. of Chemistry, Ural Branch of the Academy of Sciences, Sverdlovsk, USSR). Zh. Analit. Khim., 18: 545-7(Apr. 1963). (In Russian)

N,N′-Di-(2-hydroxy-5-sulfophenyl)-C-cyanformazan was used for the photometric determination of Zr. The sensitivity of the determination is 0.1 μg/ml of Zr. (auth)

25158 RECHERCHE ET DOSAGE DES ÉLÉMENTS TRACES. SPECTROPHOTOMÉTRIE D'ABSORPTION, SPECTROGRAPHIE D'EMISSION, POLAROGRAPHIE. (Research and Determination of Trace Elements. Absorption Spectrophotometry, Emission Spectrography, Polarography). Maurice Pinta. Paris, Dunod, 1962. 755p. 98 NF.

A survey is presented of research methods; dissolution of samples; and extraction, separation, and determination of trace elements. Bibliographies are included following each chapter. Subjects developed include trace element separation by organic complexiometry, electrochemistry, ion exchange, and chromatography; determination of trace elements by spectrophotometric, spectrometric, photometric, flame-spectrophotometric, flame-, arc-, and spark-spectrometric, polarographic, fluorescence-spectrometric, and x-ray-spectrometric methods; and radioactive and isotopic methods of trace element determination. (T.F.H.)

25159 NEUTRON ACTIVATION CHROMATOGRAPHY. Joseph Matson Steim. Thesis, University Park, Penna., Pennsylvania State Univ., 1962. 119p.

Methods were developed for the application of neutron activation analysis to the detection and quantification of biological compounds separated on paper chromatograms. Neutron activation chromatography was shown to be a practical method for the determination of molecules containing phosphorus and sulfur. The technique was extended to other biological compounds that are normally insensitive to activation analysis by chromatographing and activating bromine-containing derivatives of these materials. In addition, other related problems were studied, such as the sensitivity and precision of the method, the identification of contaminating elements in filter paper that produce undesirable background activity, the chemistry of the energetic bromine atoms produced by radiative capture of thermal neutrons, and the advantages of various counting methods. The method consists of neutron irradiation of compounds separated on paper chromatograms, then determination of the induced radioactivity in each compound by an appropriate counting technique. Compounds may be located by radioautography and identified by the usual chromatographic procedures. (Dissertation Abstr.)

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Refer also to abstracts 24788, 24789, 25722, 26113, 26785, 26788, 26790, and 26792.

25160 (ARF-1184-9) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report No. 9, February 16, 1963 to May 15, 1963. (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 5, 1963. Contract AT(11-1)-578. 49p.

Crystals grown from vacuum distilled rubidium chloride were colored additively or by γ rays. The optical absorption of these samples was determined for temperatures between 4 and 300°K and shows only a very small M band and no other bands. The values of the width at half-height of the F-band do not change in the distilled material. The uncontrolled scatter of the values for the width is less in the purified material than in previous samples. The Pekarian shape is compared with the F-band in purified RbCl. It is found that the K-band of the colored distilled RbCl is unshifted, more resolved and has a peak absorption that is substantially smaller in the purified material. The ratios of the absorption at the peak of the K-band to that of the F-band are definitely not constant among crystals having different sources and treatments. The lack of temperature dependence and the importance of impurities are properties of the K-band that contrast strongly with those of the F-band. The effects of the environment are discussed in relation to the model that proposes that the K-band is due to a higher excited state of the F-center. The relations between the Einstein A and B coefficients are discussed in detail for a point imperfection that exhibits a Stokes' shift. It is indicated that the concepts are very useful, although the usual relation derived by Einstein does not apply. This definitely disagrees with the recent arguments of Fowler and Dexter. One must define B coefficients for emission and for absorption. The basic problem is to relate the two B coefficients. This can be done by extending the original arguments of Einstein. The arguments strongly suggest that the p matrix elements are the important ones and that they are invariant for an upward or downward process. These calculations show that the experimental lifetime of the excited state of the F-center is much longer than one would expect, and indicate that basic ideas regarding the excited state must be modified. The problem of spin lattice relaxation is discussed in detail using the LCAO wave functions of Deigen and Zevin as well as the wave functions obtained by Gourary and Adrian. Careful consideration indicates that there are three mechanisms that can be responsible for spin-lattice relaxations and that uncertainties in the theory can cause large variations in the calculated values. An attempt is made to reduce the uncertainties by refined calculations. Apparatus for magnetic relaxation experiments is reviewed. The requirements for the experimental equipment for the measurement of the luminescence of the F-center in RbCl are listed. (auth)

25161 (GA-3349) A STUDY OF COPPER OXIDATION AND SOME IRRADIATION EFFECTS. Final Report. J. Martin Tobin (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Feb. 6, 1963. Contract AT(04-3)-407. 45p.

A new volumetric apparatus and a procedure for the study of the kinetics of oxidation of metals in a nuclear reactor are described. Measurements were made on the initial stages of oxidation of 99.999% pure, polycrystalline Cu wires at 100 to 300°C. The O gas was held at constant pressures during each isothermal oxidation. The pressures employed ranged from 50 to 200 mm Hg. A significant increase in logarithmic oxidation rate was observed in the presence of 2×10^6 r/hr of gamma irradiation in the temperature range 100 to 250°C. The experimental data were interpreted to be in support of the discontinuous oxidation theory of Bénard. Sharp transitions were observed in the kinetic rate laws. In general, a logarithmic rate region was observed that was both preceded and followed by regions of parabolic rate behavior. No cubic rate behavior was observed. The effect of temperature on the parabolic rate constants was found to obey the Arrhenius equation. The activation energy was found to be from 0.73 to 0.82 ev, and the logarithmic rate constants were found to be independent of temperature. The effect of pressure was observed to be marked in the early part of the oxidation. Increased pressure of O decreases the transition time and thickness where the change from parabolic to logarithmic rate behavior occurs. (auth)

25162 (LADC-5486) THE THERMAL DECOMPOSITION OF SCANDIUM FORMATE AND OXALATE. Earl L. Head and Charles E. Holley, Jr. (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 21p.

The thermal decomposition of scandium formate and scandium oxalate in vacuum and various atmospheres was studied using an automatic recording thermobalance. Scandium formate, $Sc(HCO_2)_3$, decomposes to Sc_2O_3, CO, and H_2O, as expected, plus a significant amount of CO_2 as well as detectable amounts of H_2, $HCOOCH_3$, and CH_4. In the scandium oxalate series the dodecahydrate, hexahydrate, dihydrate, anhydrous oxalate, and the oxide were identified. No definite carbonate intermediate was found. The decomposition gases, aside from hydrate water, are CO_2 and CO, with the CO_2 in excess. (auth)

25163 (PAN-404/II) A TIME-OF-FLIGHT METHOD FOR NEUTRON DIFFRACTION CRYSTAL STRUCTURE INVESTIGATIONS. B. Buras and J. Leciejewicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 6p.

A method for neutron-diffraction structure investigation of powder crystals using the variable neutron wavelength and a fixed scattering angle is discussed and checked experimentally. The measured structure factors for aluminum and lead powders fit well with the calculated ones. (auth)

25164 (TID-18684) BASIC RESEARCH IN INORGANIC AND PHYSICAL CHEMISTRY AT HIGH TEMPERATURES. (Temple Univ., Philadelphia. Research Inst.). May 15, 1963. Contract AT(30-1)-2082. 23p.

Measurements were made of the surface tension of liquid UF_4, ThF_4, and U. The density of liquid Th was determined from 1968 to 2180°K. The viscosity of the C–Fe system was measured up to 2500°K using a modified Saybolt-type viscometer. The reactivity of liquid B in a BN crucible was studied. Reactions of Mn on fusion in a ThO_2 crucible were also studied. ThB_6 was prepared by melting B in a ThO_2 crucible and by heating a mixture of B and Th powders at 2400°K. Studies of chemical reactions were started using the centrifugal plasma-jet furnace. (M.C.G.)

25165 (TID-18697) ELECTROCHEMICAL CHARACTERISTICS OF THE RARE EARTH AND YTTRIUM METALS IN PHOSPHORIC ACID. Norbert D. Greene and Linda Lee (Rensselaer Polytechnic Inst., Troy, N. Y.). [1963]. Contract [AT(30-1)-1995]. 14p.

Anodic polarization and hydrogen over-potential characteristics of the rare earth metals were determined for La, Nd, Er, Tm, Ce, Pr, Sm, Gd, Tb, Dy, Ho, Yb, and Y in 0.1N phosphoric acid using potentiostatic and galvanostatic

techniques. Yttrium, because of its similarity, was included for comparison. The anodic polarization curves of the rare earths and Y are quite similar. All have extended regions in which current density is virtually independent of electrode potential, which is characteristic of metals that readily form oxide films at their interfaces. Hydrogen overvoltage parameters were determined successfully with a few of the rare earths. The Tafel constants were large, and exchange current densities small, indicating that the reaction was occurring at an oxide surface. (P.C.H.)

25166 (TID-18769) APPLICATIONS OF ISOTOPES IN CHEMICAL KINETICS. Progress Report, September 1, 1962 to August 31, 1963. Gordon M. Harris (New York. State Univ., Buffalo). June 1, 1963. Contract AT(30-1-1578). 13p.

Research completed on kinetic studies of isotopic exchange and various substitution and decomposition reactions of selected transition metal complex ions are reported. Completed research includes: solid state reactions of oxalato complexes of transition metal ions; substitution reactions of oxalato complex ions; substitution reactions of cobalt(III) carbonato complex ions; and equilibrium studies of cobalt(III) complex ions. Abstracts of theses on kinetics and mechanism of decomposition of solid potassium trisoxalatochromium(III) and optical rotatory dispersion of some transition element octahedral complex ions are also included. (P.C.H.)

25167 (UCRL-7045) QUADRUPOLE INTERACTION AND ISOMER SHIFT IN Te^{125}. C. E. Violet, D. L. Davis, and Rex Booth (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 26, 1962. Contract W-7405-eng-48. 7p.

A Mossbauer absorption curve was obtained using a polycrystalline $NaIO_3$ source enriched with I^{125} and an absorber of tellurium (normal and Te^{125} enriched) embedded in thin Lucite disks. Asymmetry due to the existence of the Te^{125} formed by I^{125} decay in +4 and +6 valence states is noted, and the isomer shifts and quadrupole splittings associated with the states are determined by least squares fitting the data. The Mossbauer absorption spectra for Na_2TeO_3 and TeO_3 absorbers at 84°K were also measured. The +5 valence state for Te is concluded to be unstable in crystalline solids. (D.C.W.)

25168 (WCAP-1570) LITERATURE VALUES FOR SELECTED CHEMICAL/PHYSICAL PROPERTIES OF AQUEOUS BORIC ACID SOLUTIONS. D. E. Byrnes and W. E. Foster (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Jan. 1961. Contract AT(30-1)-3064. 23p.

Data are given for properties of aqueous solutions of boric acid: solubility for orthoboric acid (H_3BO_3), specific gravity, pH, ionic-dissociation constants, colligative properties (vapor-pressure lowering, boiling-point elevation, freezing-point depression), solute volatility, thermal conductivity, electric conductivity, corrosion effects, and miscellaneous properties (refractive index and heats of solution and dilution). An attempt was made to secure complete literature coverage through mid-1957. (P.C.H.)

25169 (JPRS-19324) ON THE PROBLEMS OF PHASE TRANSFORMATIONS IN THE REDUCTION OF U_4O_9. V. M. Zhukovskii (Zhukovskiy), E. (Ye.) V. Tkachenko, and V. G. Vlasov. Translated from Fiz. Metal. i Metalloved., 15: 210-14(1963). 7p. (OTS-63-21879)

Contradictory opinions on the state and structural characteristics of the phase components of the U–O system in the composition range $UO_2-UO_{2.25}$ are discussed. The reduction of U_4O_9 with decomposed ammonia and solid C was studied. The dependence of the lattice parameter of UO_2 on the amount of O introduced into it is presented. In all cases the only end product of the reduction in the experiments was the oxide UO_{2+x}, where the values of x varied, depending on the temperature and time of reduction, from 0.08 to 0.01. It was indicated that the phase UO_{2+x} actually has a cubic lattice of the fluorite type with a randomly introduced excess of O and four atoms of U in the elementary cell. (P.C.H.)

25170 COMPLEXING REACTIONS IN THE CHEMICAL TECHNOLOGY OF URANIUM. I. I. Chernyaev and G. V. Ellert. At. Energ. (USSR), 14: 383-94(Apr. 1963). (In Russian)

The aqueous chemical reactions of interest for the industrial treatment of U may be divided into precipitation and dissolution processes. The dissolution reactions are characterized by the great tendency of U to form bonds with O-containing molecules; these processes which help to break up metallic U and the oxides are brought about not only by O-containing inorganic acids but also by O-containing neutral and alkaline reagents. The complex-forming reactions involving UO_3, H_2SO_4, HNO_3, and HF with additions of F^-, PO_4^{3-}, $Hg(NO_3)$, etc. are reviewed. The equation $UO_3 + Na_2CO_3 + H_2O \rightarrow Na_4[UO_2(CO_3)_3] + 2$ NaOH indicates the reaction taking place in dilute solutions, as in the case of leaching out of ores but it does not explain all the reactions involved in the dissolution of U-rich compounds. In the dissolution of UO_2CO_3, UF_4, and other nearly insoluble compounds by means of alkali peroxides, the formation of mixed complex uranyl compounds plays an important role. Use of the precipitation reactions was somewhat restricted by the introduction of extraction and sorption processes. U concentrates containing large amounts of P, V, Fe, and Si may be treated by a method involving the formation of a water and acid-insoluble precipitate of triaquo uranyl ammonium phosphate. Oxalate compounds are often used for the precipitation. Extraction processes are carried out with a variety of alcohols, ketones, esters, phosphororganic compounds, and amines. (Review article.) (TTT)

25171 STUDY OF THE INTERACTION OF $UO_2(NO_3)_2$ WITH Na_2HPO_4 IN AQUEOUS SOLUTION. I. V. Tananaev and G. V. Rodicheva. At. Energ. (USSR), 14: 395-9(Apr. 1963). (In Russian)

In view of their low solubility, the uranyl phosphates are of interest in the analytical chemistry and the technology of U. For this reason, the $UO_2(NO_3)_2-Na_2HPO_4-H_2O$ system was investigated, attempting to establish the transition conditions in the solid phase on the basis of solubility, pH, conductivity measurements, and the determination of the apparent volume of the precipitates. Aqueous solutions of $UO_2(NO_3)_2 \cdot 6H_2O$ and Na_2HPO_4 were used as starting materials for the tests, during which the molar ratio $n = Na_2HPO_4 : UO_2(NO_3)_2$ was changed from 0.1 to 6. The experiments were carried out at 25 ± 0.1°C; the volume of the precipitates was determined at room temperature. It was found that the interaction takes place in 3 stages, with the successive formation of $(UO_2)_3(PO_4)_2$, the acid sodium uranyl phosphate $UO_2H_xNa_{1-x}PO_4$, and finally $NaUO_2PO_4 \cdot nH_2O$. The specific volume determinations indicated that 2 maxima exist, – at n = 0.67 and 2.0, corresponding to the formation of the normal uranyl phosphate and $NaUO_2PO_4$. The most suitable conditions for precipitating the uranyl ion by the phosphate are at n = 1 to 1.5 and pH of about 2.5. (TTT)

25172 HEAT CAPACITY OF HEAVY WATER AT HIGH PRESSURES AND TEMPERATURES. S. L. Rivkin and B. N. Egorov. At. Energ. (USSR), 14: 416-18(Apr. 1963). (In Russian)

Previous studies on the heat capacity of heavy water in the liquid phase at pressures up to 100 kg/cm^2 and temperatures up to 300°C (Atomnaya Energ. 7: 462(1959) No. 5) were extended to the supercritical range of heavy water in its liquid and vapor phases. A closed-circuit, adiabatic calorimeter with a highly precise (0.01°C) liquid thermostat was used for the measurements. Three series of experiments were completed: determination of the heat capacity of liquid heavy water at 5 isobaric points, 100, 150, 200, 225, and 250 kg/cm^2; determination of the same function in the vapor phase at 150, 175, and 200 kg/cm^2 at temperatures up to 450°C; and measurements in the supercritical range of the phase diagram at 225, 240, 250, 260, 275, and 300 kg/cm^2 at temperatures from 330 to 360 to 450°C. The heat capacity values in kcal/°C kg are tabulated. The experimental error is estimated at 0.35% for the liquid and the unsaturated vapor and at 1 to 2% near the saturation lines and heat capacity maxima at the supercritical isobars. (TTT)

25173 AN X-RAY DIFFRACTION STUDY OF INORGANIC COMPLEXES $KHgBr_3 \cdot H_2O$ AND $Na_5Zr_2F_{13}$. R. M. Herak, Lj. M. Manojlović, and S. S. Malčič. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 21-5(Jan. 1963). (In English)

Space groups, unit-cell dimensions, and other x-ray diffraction data on $KHgBr_3 \cdot H_2O$ and $Na_5Zr_2F_{13}$ compounds were determined. (auth)

25174 POTENTIAL FIELD AND FORCE CONSTANTS OF SOME OCTAHEDRAL XY_6 TYPE MOLECULES. G. Nagarajan (Annamalai Univ., Annamalainagar, South India). Bull. Soc. Chim. Belg., 72: 276-85(Mar.-Apr. 1963). (In English)

Vibrational analyses for the octahedral XY_6 type molecules possessing the symmetry point group O_h are discussed. The construction and orientation of symmetry coordinates, F and G matrices, following the methods outlined by Wilson were clearly deduced. By making use of the redundant symmetry coordinates, a set of force constants was obtained for the molecules SF_6, SeF_6, TeF_6, MoF_6, WF_6, UF_6, NpF_6, PuF_6, ReF_6, OsF_6, IrF_6, and PtF_6. (auth)

25175 STUDY BY THERMAL DECOMPOSITION OF URANYL AND URANIUM(IV) OXALATES. [PART] IV. René Bressat, Bernard Claudel, and Yves Trambouze (CNRS, Lyon). Bull. Soc. Chim. France, No. 3, 464-70 (Mar. 1963). (In French)

The thermal decomposition of trihydrated uranyl oxalate and hexahydrated uranium(IV) oxalate was studied under various conditions with different techniques. The intermediate phases appearing during the thermolysis could be isolated and analyzed. (tr-auth)

25176 THE SYNTHESIS AND PROPERTIES OF THE ANHYDROUS HEXACHLOROTITANATES OF RUBIDIUM AND CESIUM. R. L. Lister and S. N. Flengas (Univ. of Toronto). Can. J. Chem., 41: 1548-51(June 1963). (In English)

The hexachlorotitanates of Rb and Cs were produced in a closed system, following the reaction $2MCl\ (s) + TiCl_4\ (g) = M_2TiCl_6\ (s)$, where M is respectively Rb and Cs. With the $TiCl_4$ vapor at 1 atm, the optimum temperature for both reactions is 410 ± 10°C. (auth)

25177 A KINETIC ANALYSIS OF THE EXCHANGE OF DEUTERIUM WITH HYDRIDES. R. J. Mikovsky and J. Wei (Socony Mobil Oil Co., Inc., Paulsboro, N. J.). Chem. Eng. Sci., 18: 253-8(May 1963).

In the exchange reaction between deuterium and hydride molecules, the consecutive single-step mechanism is characterized by interactions only between the ith deutero-isomer and the (i + 1) and (i – 1) isomers. Rate equations were set up on this basis and their exact and unique solutions found. This permits the deutero-isomer distribution to be expressed analytically as a function of the time. If the initial state contains only undeuterated hydride or a binomial distribution of isomers, the distribution has been shown to maintain its binomial character to equilibrium. An application of the analysis to two exemplary cases was made. (auth)

25178 KINETIC CHARACTERISTICS OF THE REACTION OF CHLORINE TRIFLUORIDE WITH URANIUM TETRAFLUORIDE. Hoang Nguyen-Nghi (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 256: 3465-7 (Apr. 17, 1963). (In French)

The reaction of pure gaseous ClF_3 on solid UF_4 was studied. From 25 to 50°C, the kinetic law is very approximately $(1 - C)^{1/3} = 1 - kt$, where C designates the degree of progress of the reaction at the moment t. Within the limits of reproducibility of the measurements, it appears that pressure of ClF_3 exercises only slight effect on the velocity constant k and that the activation energy of the reaction is low (about 6.3 ± 4.1 kcal/mole). (tr-auth)

25179 EFFECT OF WATER ON THE ISOTOPIC EXCHANGE OF OXYGEN ATOMS BETWEEN SILICATES AND CARBON DIOXIDE. Jeannine Fructus-Ricquebourg (Laboratoire de Minéralogie-Cristallographie, Sorbonne, France). Compt. Rend., 256: 3677-9(Apr. 22, 1963). (In French)

In order to prove the role of water in exchange phenomena, isotopic exchange reactions between a silicate and CO_2 (completely dry or in the presence of water) were studied. The results show that the isotopic exchange with completely dry CO_2 is very low with R = 0.03. The presence of small quantities of water increases the rate of exchange considerably. (J.S.R.)

25180 KINETICS OF THE REACTION OF WATER VAPOR ON URANIUM VAPOR DEPOSITED IN THIN FILMS. Jean Besson and Jean-Paul Santon (CEN, Grenoble, France). Compt. Rend., 256: 3702-4(Apr. 22, 1963). (In French)

The reaction of water vapor on vapor-deposited U films was studied for temperature from 160 to 410°C and for pressures from 1 to 15 mm of Hg. The final reaction product is UO_2. The shape of the kinetic curves obtained and the variations of the reaction velocity as a function of the temperature and pressure suggest the presence of two distinct processes. A diffusion process at low temperature in a dioxide layer leads to parabolic kinetics, then to linear (diffusion in a layer of constant thickness) kinetics, only slightly affected by pressure. An interface process at higher temperatures has linear kinetics strongly affected by pressure. (J.S.R.)

25181 THE SYNTHESIS AND PROPERTIES OF THE LOWER, PERRHENATE CRYSTAL HYDRATES OF YTTRIUM, LANTHANUM AND THE OTHER LANTHANIDES. V. E. Plyushchev, V. M. Amosov, and M. B. Varfolomeev (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 150: 105-8(Mar. 1, 1963). (In Russian)

In order to prepare about 5 grams of the perrhenate, a sample of 1.2 to 1.4 grams of rare earth oxide (which corresponds to about a 20% excess of Me_2O_3) was reacted with 35 ml of a solution containing 240 g/l of $HReO_4$. A small amount of H_2O_2 was added to accelerate the reac-

tion if necessary. Since $HReO_4$ is a strong acid, the rare earth oxide reacted completely according to the following reaction: $Me_2O_3 + 6HReO_4 = 2Me(ReO_4)_3 + 3H_2O$. The rare earth perrhenate was isolated by filtering off the excess Me_2O_3, and evaporating the filtrate to dryness on a water bath at 75 to 80°C. Chemical analysis showed that the ratio of Me_2O_3 to Re_2O_7 was 1:3 in the rare earth perrhenate. Monohydrates are formed for the La, Ce, Pr, Nd, Sm, Eu, and Gd perrhenates, while dihydrates are formed with the Tb, Dy, Ho, Er, Tu, Yb, Lu, and Y compounds. The water of crystallization was lost readily to give the anhydrous salt without decomposition of the perrhenate. The anhydrous salt can be heated to 500 to 550°C without any loss in weight. The refractive indices of the rare earth perrhenates are tabulated. (TTT)

25182 ON THE FORMS OF BERYLLIUM TRANSPORT IN ALKALINE METASOMATOSE. I. N. Govorov and A. A. Stunzhas (Far East Geological Inst., Siberián Academy of Sciences, Vladivostok, USSR). Geokhimiya, No. 4, 383-90 (Apr. 1963). (In Russian)

In dissolving Be carbonate in solutions of alkali carbonates and halides complex Be carbonates are obtained that are stable in alkaline solutions at a pH from 6.8–7 to 11.3–11.8 and at increased temperatures. The capacity of halogen-containing potassium carbonate beryllates to evaporate from solutions at a weak heating was detected. Crystals of earlier unknown complex potassium carbonate beryllates containing halogens and hydroxyl were isolated and the composition of a chlorine-containing salt was established that is expressed by the formula $K_8[Be_4(CO_3)_6(OH)_2Cl]$. Owing to the high solubility and stability of halogen-containing potassium carbonate beryllates, they are considered the most probable form of Be transport. (auth)

25183 ON THE CHEMICAL COMPOSITION OF MINERALS OF THE BERYL GROUP, ON THE CHARACTER OF ISOMORPHISM AND THE POSITION OF THE PRINCIPAL ADMIXTURES IN THE CRYSTAL STRUCTURE. V. G. Feklichev (Inst. of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements, Moscow). Geokhimiya, No. 4, 391-401(Apr. 1963). (In Russian)

The degree of entering of definite alkaline, alkaline-earth atoms into the beryl composition depends on genetic factors. The constancy in the relation of the sum of alkaline atoms (and Ca) and water molecules in maximum alkaline beryls is emphasized. The idea of a limited isomorphism of Be and of alkalies in beryl is given, the upper limit of entrance into beryl of a sum of alkaline atoms (and Ca) and water molecules is established, and the impossibility of the existence of an alkaline beryl without Be is suggested. The limited isomorphism in alkaline and alkaline-earth beryls may be expressed as formulas characterizing the composition of minerals of isomorphic series. The situation of all alkaline and alkaline-earth atoms (excepted Mg) and water molecules on one vertical axis in clearly seen canals in the beryl structure is substantiated. (auth)

25184 SOLVENT INFLUENCE AND SPIN COUPLING IN THE NUCLEAR MAGNETIC RESONANCE OF O^{17}. H. A. Christ and P. Diehl (Universität, Basel). Helv. Phys. Acta, 36: 170-82(1963). (In German)

Spectra of substances with natural abundance of O^{17} were observed in solution and at various temperatures. Chemical shifts of nitro-, aldehyde-, and ketogroups in aliphatic and aromatic compounds were investigated. The differences observed are explained by mesomeric effects. Steric hindrance in orthosubstituted nitrobenzenes can be demonstrated. The chemical shift of carbonyl groups is dependent on solvents. The largest difference measured is of the order of 50 ppm. O^{17}-P^{31} spin coupling constants between 90 and 200 cps were observed. For certain molecules it is necessary to work at high temperatures, so that the line width, which is caused by quadrupole relaxation, is reduced to a value slightly below the coupling constant. (auth)

25185 PREPARATION OF METALLIC THORIUM DIIODIDE. Ronald J. Clark and John D. Corbett (Ames Lab., Ames, Iowa). Inorg. Chem., 2: 460-3(June 1963). (IS-572)

Reaction of sublimed ThI_4 and excess, high purity thorium in sealed tantalum containers at about 800° results in the quantitative formation of the gold-colored ThI_2 on the surface of the metal. The compound is stable in tantalum up to 883°, where it decomposes incongruently to Th(s) and iodide-rich liquid of composition ca $ThI_{3.4}$. The metallic character suggested by the appearance of the diiodide is confirmed by its very low electrical resistance and by its diamagnetism ($\chi_M = (-80 \pm 20) \times 10^{-6}$ e.m.u.). The compound is therefore not a true thorium (II) salt but probably should be formulated as $Th^{4+}(I^-)_2(e^-)_2$, with the electrons in a metal-like conduction band. There is no evidence for an analogous $ThBr_2$. Correlation of the results with earlier, contradictory studies of the ThI_4–Th system is substantially lacking, as these have claimed only dark colored thorium "dihalides." It is concluded that many prior reports of these compounds probably were vitiated by extensive side reactions with the glass containers. Similar container reactions have evidently also affected prior studies of the black, diamagnetic phase near or above ThI_3 in composition. (auth)

25186 ORDERING IN COMPOUNDS OF THE $A(B'_{.33}Ta_{.67})O_3$ TYPE. Francis Galasso and Jane Pyle (United Aircraft Corp., East Hartford, Conn.). Inorg. Chem., 2: 482-4(June 1963).

Several compounds with the general formula $A(B'^{II}_{.33}Ta^{V}_{.67})O_3$, where A is a barium or strontium ion and B′ is a divalent metal ion, were prepared and studied by means of x-ray diffraction techniques. Results of this investigation show not only that the difference in the charge of the B ions causes ordering, but also that the difference in the size of these ions is an important factor in influencing the degree of long-range ordering which exists in the structure of these compounds. (auth)

25187 URANIUM–OXYGEN BOND LENGTHS IN URANYL SALTS: URANYL FLUORIDE AND URANYL CARBONATE. Henry R. Hoekstra (Argonne National Lab., Ill.). Inorg. Chem., 2: 492-5(June 1963). (TID-17428; UAC-6907)

Infrared absorption curves for carefully purified samples of UO_2F_2 and UO_2CO_3 were obtained. Using the new frequencies and Badger's rule, the uranyl bond lengths are calculated as 1.71 Å in UO_2F_2 and 1.72 Å in UO_2CO_3, in very good agreement with the Zachariasen bond length-bond strength relationship. Evidence is given to show that the U–O bond length in different uranyl salts shows relatively little variation (1.71 to 1.76 Å) and that the bond order in the simple anhydrous salts may approach three. (auth)

25188 DIRECT SYNTHESIS OF COMPLEX METAL HYDRIDES. E. C. Ashby, G. J. Brendel, and H. E. Redman (Ethyl Corp., Baton Rouge, La.). Inorg. Chem., 2: 499-504 (June 1963).

The direct synthesis of $NaAlH_4$, $LiAlH_4$, $KAlH_4$, and $CsAlH_4$ from the elements was accomplished. The reaction

of the alkali metal, aluminum, and hydrogen proceeds at moderate temperatures and pressures to produce nearly quantitative yields of high purity alkali metal aluminum hydride. The method affords a convenient laboratory as well as commercial route to $NaAlH_4$ and $LiAlH_4$. The effects of temperature, pressure, solvent, and other variables were determined. A mechanism for the reaction is discussed. The reaction of sodium, aluminum, hydrogen, and olefins to produce compounds of the structure $NaAlR_nH_{4-n}$ also was accomplished. A promising route to unetherated $LiAlH_4$ was found. The route involves the metathetical reaction of $NaAlH_4$ and LiCl in diethyl ether. The effects of solvents and temperature on yield of $LiAlH_4$ were investigated. A convenient method of isolation and purification of $LiAlH_4$ was developed which produces $LiAlH_4$ in approximately 99% purity. (auth)

25189 THE PREPARATION AND PROPERTIES OF SOME PENTACHLOROALKOXO COMPLEXES OF NIOBIUM(IV). R. A. D. Wentworth and C. H. Brubaker, Jr. (Michigan State Univ., East Lansing). Inorg. Chem., 2: 551-4(June 1963).

A number of complexes of the type $(BH)_2Nb(OR)Cl_5$ were prepared by electrolytic reduction of $NbCl_5$ in HCl-saturated alcohols, followed by the addition of alcoholic solutions of BH^+ ions (B is an amine such as CH_3NH_2, pyridine, quinoline, etc.). All compounds show normal, spin-only paramagnetism for the d^1 ion. Spectra of aromatic "-inium" salts are complicated and suggest that there is an interaction with the $Nb(OR)Cl_5^-$ ion. The interaction seems to result in weakening of the aromatic C–H and the alkoxo C–O bonds and a distortion of the complex ion to greater tetragonality. (auth)

25190 COMPLEXES OF THE RARE EARTHS. VI. N-HYDROXYETHYLIMINODIACETIC ACID. Larry C. Thompson and Judith A. Loraas (Univ. of Minnesota, Duluth). Inorg. Chem., 2: 594-7(June 1963).

The formation constants of the complexes between the rare earth ions and N-hydroxyethyliminodiacetic acid (HIMDA) were investigated at 25° and $\mu = 0.1$ (KNO_3). Both 1:1 and 2:1 chelates of unusually large stability were found. Trends in the formation constants are discussed and it is shown that the data can be explained by assuming that the hydroxyethyl group is coördinated in both the 1:1 and 2:1 chelates. The data also indicate that the rare earth ions have a coordination number larger than six in these species. (auth)

25191 THE NATURE OF THE COMPOUND OBTAINED FROM AQUEOUS CESIUM CHLORIDE SOLUTION AND HYDROGEN CHLORIDE. Arthur G. Maki and Robert West (National Bureau of Standards, Washington, D. C. and Univ. of Wisconsin, Madison). Inorg. Chem., 2: 657-8(June 1963).

Infrared spectra were measured for the undeuterated and deuterated forms of a new compound formed from aqueous CsCl solutions saturated with HCl. The spectra indicate that the compound is probably a mixed oxonium salt, $4\,CsCl \cdot 3\,H_3OCl$. (D.L.C.)

25192 THE COVALENT RADIUS OF XENON. R. T. Sanderson (Univ. of Iowa, Iowa City). Inorg. Chem., 2: 660-1(June 1963).

The bond length in XeF_4 is calculated from electronegativity considerations for comparison with the observed value. From the XeF_4 electronegativity value of 4.05, the radius sum of Xe and F is computed to be 2.12 A, or 1.95 A for single Xe-F bonds. This latter value is in good agreement with the observed value of 1.92 ± 0.03 A. The bond lengths in XeF_2 and KrF_4 are predicted to be ~2.11 and ~1.84 A, respectively. (D.L.C.)

25193 INFRARED ABSORPTION SPECTRA OF HAFNIUM(IV) THIOCYANATE COMPLEXES. Yu. Ya. Kharitonov, I. A. Rozanov, and I. V. Tananaev (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, No. 4, 596-601(Apr. 1963). (In Russian)

The infra-red absorption spectra (400 to 4000 cm^{-1}) of $HfO(CNS)_2 \cdot CsCNS \cdot 2H_2O$, $HfO(CNS)_2 \cdot (PyH)\,CNS \cdot H_2O$, $2HfO(CNS)_2 \cdot 3(PyH)\,CNS \cdot H_2O$, $(PyH)_2[Hf(CNS)_6]$, $HfOCl_2 \cdot 8H_2O$ and of thermal decomposition products $HfO(CNS_2) \cdot CsCNS \cdot 2H_2O$ at 105 to 300° were described. The $HfO(CNS)_2 \cdot CsCNS \cdot 2H_2O$, $HfO(CNS)_2 \cdot (PyH)\,CNS \cdot H_2O$ and $2HfO(CNS)_2 \cdot 3(PyH)CNS \cdot H_2O$ compounds contain HfO hafnyl groups. All thiocyanate complexes examined contain thiocyanate groups bonded with hafnium by an atom of nitrogen. The $2HfO(CNS)_2 \cdot 3(PyH)CNS \cdot H_2O$ group obviously contains the bridge-thiocyanate group. The compound $HfOCl_2 \cdot 8H_2O$ does contain HfO groups. (R.V.J.)

25194 CARBONATE LIGAND AND HYDROGEN EXCHANGE STUDIES OF SOME CARBONATOAMINE COBALT(III) COMPLEX IONS: A GENERAL MECHANISM FOR THE LIGAND CARBONATE EXCHANGE REACTION IN AQUEOUS SOLUTION. Gabriel Lapidus and Gordon M. Harris (Univ. of Buffalo). J. Am. Chem. Soc., 85: 1223-8(May 5, 1963).

Several studies have been made in recent years of the carbonate substitution reactions in aqueous solution of carbonatocobalt(III) complex ions of the general type $Co\,L\,CO_3^+$, where L represents an amine ligand grouping. Results are reported of a detailed study of the kinetics of the carbonate exchange reactions of $Co(pn)_2CO_3^+$ (pn = propylenediamine), and includes a complete reassessment of earlier data on the reactions of the analogs in which the group L is pentaammine (N_5), tetraammine (N_4), ethylenediamine (en_2), cis-diamminoethylenediamine (N_2en), and trimethylenediamine (tn_2). New data on the acidity dependence of the reactions confirmed that the whole series react by a common dual mechanism involving both second-order carbonate/carbonato exchange and pseudo-first-order equation. The rate law is of the form: $R = k'\alpha\beta ab + k''\alpha a$, where a and b are the total concentrations of complex and free carbonate, respectively, and α and β are functions of the form $Kh/(Kh + 1)$, with h = hydrogen ion concentration, and K a protonation equilibrium constant. Much of the variation in reactivity between members of the series appears to be of stereochemical origin, in which intramolecular O–H–N hydrogen-bonding may play a significant role. Evidence concerning this latter factor was adduced from rate studies of the deuterium exchange between the amine hydrogens of several of these complexes and the solvent water. An important conclusion from the study is that it is only a protonated species, whether of complexed or free carbonate, which takes part in the reactions at an appreciable rate. (auth)

25195 THE METAL-METAL BONDED, POLYNUCLEAR COMPLEX ANION IN $CsReCl_4$. J. A. Bertrand, F. A. Cotton, and W. A. Dollase (Massachusetts Inst. of Tech., Cambridge). J. Am. Chem. Soc., 85: 1349-50 (May 5, 1963).

A preliminary report is given of the structure of $CsReCl_4$. It was found to have a large orthorhomic unit cell (a = 14.06 Å, b = 14.00 Å, c = 10.69 Å) containing 12 formula units and a space group Ama2. The Re-Re distance in the complex anion $[Re_3Cl_{12}]^{3-}$ is 2.47 Å, the Re-Cl distances range from 2.36 to 2.52 Å, and the adjacent Cl-Cl distances are 3.28 Å. The short Re-Re distances are discussed, and some related plausible structures for some other rhenium(III) complexes are described. (D.L.C.)

25196 THE THERMAL DECOMPOSITION OF OXALATES. PART II. THERMOGRAVIMETRIC ANALYSIS OF VARIOUS OXALATES IN AIR AND IN NITROGEN. D. Dollimore, D. L. Griffiths, and D. Nicholson (Royal Coll. of Advanced Tech., Salford, Lancs, Eng.). J. Chem. Soc., 2617-23(May 1963).

The thermogravimetric analysis of several oxalates in air and in nitrogen is reported. It is shown that in some cases the decomposition proceeds directly to the oxide, but that in others the metal is first formed and is subsequently oxidized in air to the oxide. In general, the decomposition in nitrogen is simpler than in air, producing either the metal or a lower oxide. (auth)

25197 CATALYSIS OF THE ELIMINATION OF CHLORIDE ION FROM CHLORO(ETHYLENEDIAMINETRIACETATOACETATE) COBALTATE(III) AND ITS CONJUGATE ACID BY METAL CATIONS. R. Dyke and W. C. E. Higginson (Univ. of Manchester, Eng.). J. Chem. Soc., 2788-97(May 1963).

Activation energies and entropies were found for the elimination of chloride ion from chloro(ethylenediaminetriacetatoacetate)cobaltate(III) catalyzed by various metal cations in aqueous solutions. A mechanism is proposed which involves the interaction of both the leaving chloride ion and the free carboxylate group with the catalyst. The elimination of chloride ion from the conjugate acid of this cobalt(III) complex is much less susceptible to cationic catalysis. (auth)

25198 THE INFRARED ABSORPTION OF ^{18}O-LABELLED SALTS. PART II. SODIUM SULPHITE. E. Petreanu, S. Pinchas, and David Samuel (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Soc., 2822-3(May 1963).

The infrared absorptions of Nujol mulls of normal and enriched [O^{18} 57 atom %] sodium sulfite in the 3700 to 400 cm^{-1} region are reported. The assignment of ν_3 of the SO_3 ion is discussed and the frequency of 1164 cm^{-1} suggested for it. The ν_3 and ν_4 bands of SO_3^{16} ion are split in the case of $SO^{16}O_2^{18}$ ion as a result of its lower symmetry. The observed ratios of the $SO^{16}O_2^{18}$ ion frequencies to the corresponding SO_3^{16} ion frequencies are compared with the theoretically calculated ratios; agreement is only moderate. (auth)

25199 THE REACTION BETWEEN AQUEOUS URANYL ION AND THE SURFACE OF SILICA GEL. Jimmy Stanton and Russell W. Maatman (Univ. of Mississippi, University). J. Colloid Sci., 18: 132-46(Feb. 1963).

An apparent equilibrium constant, K, for the reaction $UO_2^{2+} + 2(\equiv SiOH) \rightleftharpoons UO_2(OSi)_2 + 2H^+$ was determined at 0.01 to 0.4 M $UO_2(NO_3)_2$ at five temperatures from 5 to 65°C. Extrapolation to infinite dilution gives K's from which $\Delta F^\circ_{298} = 8.2$ kcal/mole, $\Delta H^\circ = 3.5$ kcal/mole, and $\Delta S^\circ_{298} = -16$ eu. The results are compared with the known structure of UO_3 and the aqueous uranyl ion, and it is suggested that the axis of the linear uranyl ion is either parallel and close to the plane of the surface, or actually in the plane of the surface. The two silanol oxygens, which become negatively charged when the uranyl ion replaces hydrogens of the groups, lie near the equator of the uranyl ion and bond to the positively charged uranium atom. (auth)

25200 THE OXIDATION OF GRAPHITE AT TEMPERATURES OF 600° TO 1500°C AND AT PRESSURES OF 2 TO 76 TORR OF OXYGEN. E. A. Gulbransen, K. F. Andrew, and F. A. Brassart (Westinghouse Electric Corp., Pittsburgh). J. Electrochem. Soc., 110: 476-83(June 1963).

Gravimetric, pressure change, and mass spectrographic methods were used to study the kinetics of the oxidation reaction. The discovery of the surface area effect greatly aided the study of the primary chemical reaction up to 1000°C and the diffusion-controlled region of oxidation. By use of small samples having surface areas of 0.13 cm^2, rates of oxidation of 5.9×10^{18} atoms/cm^2/sec were measured in a static system. Experimentally the rate of oxidation of carbon is governed by three factors; the primary chemical reaction; the diffusion-controlled reaction; and the theoretical rate based on collision theory. (P.C.H.)

25201 THE MUTUAL SOLID SOLUBILITY OF HAFNIUM CARBIDE AND URANIUM MONOCARBIDE. N. H. Krikorian, W. G. Witteman, and M. G. Bowman (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc., 110: 560-3(June 1963). (LADC-6180)

In contrast to the miscibility gap previously reported for the system HfC–UC, complete solid solubility of these carbides at 2000°C was demonstrated. Included are the preparation, heating conditions, x-ray data, and chemical analysis of the starting materials and the solid solutions. (P.C.H.)

25202 LOW-TEMPERATURE THERMAL EXPANSION OF THE GROUP 4a CARBIDES. N. K. Krikorian, T. C. Wallace, and James L. Anderson (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc., 110: 587-8(June 1963). (LADC-5560)

Linear coefficients of thermal expansion were measured for TiC, ZrC, and HfC at 26 and –190 ± 1°C. On comparing the lattice parameters of HfC and ZrC as a function of C content, it appears that $ZrC_{0.95}$ has a lattice constant higher than that of $ZrC_{0.97}$, while $HfC_{0.89}$ has a parameter similar to that of $HfC_{0.95}$. The data are tabulated. (P.C.H.)

25203 VALENCY CHANGES IN THE SURFACE OXIDE FILMS ON METALS. H. S. Isaacs and J. S. Llewelyn Leach (Imperial Coll. of Science and Tech., London). J. Electrochem. Soc., 110: 680-7(June 1963).

Two methods are described by which a square current pulse may be used to measure the surface capacity and resistance of metal electrodes immersed in an electrolyte. The methods were applied to the study of electrodes of Al, Ta, and Zr, and to electrodes of Ti, Nb, Va, and U. The first group shows surface capacities that vary with the H content of the oxide but which are always less than those of the double layers. The second group shows surface capacities greatly in excess of those associated with double layers, and these were interpreted in terms of reversible reactions occurring within the oxide layers. (auth)

25204 STUDIES ON THE KINETICS OF THE DECOMPOSITION OF THE CHLORO-COMPLEX OF CERIUM(IV) IN SULPHURIC ACID MEDIUM. K. K. Sengupta, P. K. Pal, and S. P. Moulik (University Colleges of Science and Tech., Calcutta). J. Indian Chem. Soc., 40: 217-21(Mar. 1963). (In English)

The reaction between cerium(IV) and chloride ion proceeds through the initial formation of a red-colored complex that is unstable and decomposes gradually. The kinetics of the decomposition reaction obey the first-order law. The activation energy calculated is 19.35 kcal/mole. H_2SO_4 retards the rate of the decomposition of the complex. (auth)

25205 ON THE PREPARATION OF ZIRCONIUM GLUTARATE GELS. A. Mukherji and S. P. Mushran (Univ. of Allahabad, India). J. Indian Chem. Soc., 40: 245-6(Mar. 1963). (In English)

Transparent and stable gels of zirconium glutarate were prepared by metathesis of sodium glutarate and zirconium nitrate solutions under controlled conditions. The gelling time ranged from 120 to 436 min at a bath temperature of 35°C. In the presence of dioxane, however, the gelling time was considerably reduced. Measurement of the H^+ ion concentration of the gel-forming mixture showed that zirconium glutarate gels are obtained at the pH range 2 to 2.3, establishing the acidic nature of the gels. (P.C.H.)

25206 PSEUDOMORPHIC DECOMPOSITION OF URANIUM PEROXIDE INTO UO_3. E. H. P. Cordfunke (Reactor Centrum Nederland, Petten, Netherlands) and A. A. Van Der Giessen. J. Inorg. Nucl. Chem., 25: 553-5(May 1963).

In the decomposition of pure $UO_4 \cdot 4aq$ into amorphous UO_3, interesting pseudomorphism was observed by means of electron microscopy. If the peroxide contains small amounts of nitrate, thermal decomposition leads to crystalline α-UO_3, which transformation is accompanied by a change in size and shape of the particles. (auth)

25207 AQUEOUS SYSTEMS AT HIGH TEMPERATURE. IX. INVESTIGATIONS ON THE SYSTEM Li_2SO_4–H_2SO_4–H_2O AND ITS D_2O ANALOGUE, 200-470°C: SOLUBILITIES AND CRITICAL PHENOMENA. William L. Marshall, Ruth Slusher, and Fred J. Smith (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 25: 559-66(May 1963).

The solubilities of Li_2SO_4 in H_2SO_4–H_2O and in D_2SO_4–D_2O solutions in equilibrium with vapor were determined at temperatures between 200 and 350°C, and at concentrations of free acid from 0 to 1.5 molal. Solubilities in H_2O media at 200° varied from 2.75 m in H_2O to 2.83 m in 0.85 m H_2SO_4, and at 350° from 0.118 m in H_2O to 2.38 m in 1.46 m H_2SO_4. Corresponding solubilities in D_2O media were from 10 to 40 per cent lower. The solubilities of stoichiometric Li_2SO_4 in H_2O were in good agreement with those published recently by Elenevskaya and Ravich. Temperatures of critical phenomena (where liquid ≡ vapor) varying between 374 and 470° were determined visually for solutions of Li_2SO_4, D_2SO_4, and D_2O at concentrations of SO_3 from 0.02 to 2.5 molal and at molal ratios, $m_{Li_2O}: m_{SO_3}$, varying from 0 to approximately 0.5. At higher molal ratios than about 0.5 and at concentrations of SO_3 of approximately 0.05 m and above, Li_2SO_4 crystallized from the liquid phases. The formation of DSO_4^- ions can be responsible both for the high solubility of lithium in the supercritical fluid and, except at low SO_3 molalities, the limit of the critical curves to a maximum molal ratio near 0.5. (auth)

25208 SPECTRUM OF DOUBLY IONIZED GADOLINIUM. Wm. R. Callahan (Johns Hopkins Univ., Baltimore). J. Opt. Soc. Am., 53: 695-700 (June 1963).

The spectrum of doubly ionized gadolinium was photographed and measured over the region 1900–12,000 Å. The transitions involving 18 levels and 42 lines were classified. The Coulombic and spin-orbit matrix elements of the $f^7(^8S_{7/2})l$ states were evaluated and the energy levels calculated. Close agreement was obtained between the calculated and experimental values. These calculations indicate that the $4f^7(^8S_{7/2})6p$ states are close to J_1j coupling while those of $4f^7(^8S_{7/2})5d$ are close to LS coupling. (auth)

25209 VACUUM WAVELENGTHS OF Kr^{86}, Hg^{198}, AND Cd^{114}. K. M. Baird, D. S. Smith, and K. H. Hart (National Research Council, Ottawa). J. Opt. Soc. Am., 53: 717-20(June 1963).

Vacuum-wavelengths values are given for a number of visible lines, emitted by Kr^{86}, Hg^{198}, and Cd^{114}, which are useful spectroscopic and metrological standards. The wavelengths are based on a number of Fabry-Perot interferometer measurements during the past few years; some of the values were also confirmed by independent measurements on Michelson interferometers. Perturbations to the wavelengths are discussed. (auth)

25210 PERMEATION RATES OF ELECTROLYTIC HYDROGEN AND DEUTERIUM THROUGH IRON. Joseph W. Pitts. J. Res. Natl. Bur. Std., 67C: 111-18(Apr.-June 1963).

The relative permeation rates of electrolytically discharged hydrogen, deuterium, and mixtures of the two through sheet-iron cathodes were measured, and values for both the separation factor and the combined separation-permeation factor were determined. Also, data were obtained on the influence of strain, surface condition, and chemically precharged hydrogen on the permeation rate of electrolytic hydrogen. (auth)

25211 BURNING TEMPERATURES OF URANIUM AND ZIRCONIUM IN AIR. Edward M. Mouradian and Louis Baker, Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 15: 388-94(Apr. 1963).

The burning temperatures and oxidation rates for uranium and zirconium metals in air were investigated analytically. The calculations were based on the assumption that the metal–oxygen reaction is controlled by atmospheric diffusion. Reaction is assumed to be limited by the rate at which oxygen can diffuse through a nitrogen-rich boundary layer. Expressions for mass transfer were obtained by applying the Lewis relation to accepted heat transfer correlations. Calculations were made for the case of vertical plates (foils), horizontal cylinders (wires), and spheres in both natural and forced convection. Characteristic dimensions ranging from 0.02 to 10 cm and flow velocities up to 3162 cm/sec (70 mph) were considered. Computed burning temperatures were compared with experimental measurements of the maximum temperature reached by burning foils of uranium, zirconium, and a zirconium alloy containing 14.9 wt % titanium in natural convection. Experimental temperatures with zirconium were higher than calculated values while uranium temperatures were somewhat below theoretical. The calculations, however, correctly described the variation of burning temperature with foil width and appear to be good evidence for the proposed model of burning. (auth)

25212 BURNING VELOCITIES OF URANIUM AND ZIRCONIUM IN AIR. L. Leibowitz, L. Baker, Jr., J. G. Schnizlein, L. W. Mishler, and J. D. Bingle (Argonne National Lab., Ill.). Nucl. Sci. Eng., 15: 395-403(Apr. 1963).

Measurements were made of the maximum burning temperatures and the propagation velocities along strips of uranium and zirconium foils and wires burning in air. Measurements were made using either a high-speed motion picture camera or a specially constructed two-slit electronic pyrometer. Burning temperatures and propagation velocities were measured as a function of both sample width and sample thickness. It was found that burning propagation velocities could be reasonably well described by a thermal propagation theory similar to one applied to flame propagation in gases. Variation of propagation rates with thickness and width of foil were correctly described by the theory. The results of the study are applicable to the combustion of isolated pieces of uranium and zirconium scrap but not directly to the more complicated case of the combustion of large aggregates. Some of the additional factors involved in large aggregate fires are discussed. (auth)

25213 THE EFFECT OF HALOGENATED HYDROCARBONS ON THE BURNING OF URANIUM AND ZIRCONIUM. L. Leibowitz, J. G. Schnizlein, and L. W. Mishler (Argonne National Lab., Ill.). Nucl. Sci. Eng., 15: 404-10(Apr. 1963).

It was found that the addition of several percent of any of a score of halogenated hydrocarbons to air in which uranium or zirconium foil is burning will markedly lower both the burning propagation velocity and the maximum burning temperature. For example, the addition of 2% CH_3Cl will lower the burning propagation velocity of 0.013 × 0.3 cm uranium foil from 0.52 to 0.41 cm/sec; the maximum burning temperature is lowered from 1375 to 1225°C. The use of 2% CH_3CHF_2 prevented burning from progressing along the entire length of this foil. For combustion of 0.002 × 0.3 cm zirconium foil, CF_2BrCF_2Br, CF_3Cl, and CF_3Br were found to be effective inhibiting agents. Because of the flammability of CH_3CHF_2, measurements were made of the effect of several halogenated agents on the flammability limits of that compound. It was found for example, that a 1:1 mixture of CH_3CHF_2 and CF_3Cl was nonflammable and effectively inhibited burning propagation of the uranium foil used in this study. Measurements with the uranium foil showed chlorine and bromine containing compounds to lower significantly the metal ignition temperature. That the halogenated agents may have opposite effects on ignition and steady combustion is a reflection of the difference in the controlling factors in the two cases. (auth)

25214 SURFACE ELECTRICAL STUDIES OF PLUTONIA AND THORIA SUSPENSIONS. PART I. R. G. Sowden and K. E. Francis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Sci. Eng., 16: 1-11(May 1963).

Studies were made of the electrophoretic behavior of various samples of plutonia and thoria. Significant differences were observed between samples of the same compound having a different history, but general common trends were apparent. Differences in behavior between plutonia and thoria were no greater than those between different samples of either compound. Adsorption isotherms were calculated using a standard model of the double layer. The data suggest that both plutonia and thoria surfaces adsorb multivalent cations much more readily than monovalent ones. Anions are adsorbed to a varying degree, with the notable exception of nitrate. Both hydrogen and hydroxyl ions significantly affect the surface charge density. The adsorption isotherms do not obey a simple Langmuir law. (auth)

25215 SURFACE ELECTRICAL STUDIES OF THORIA AND PLUTONIA SUSPENSIONS. PART II. R. G. Sowden, B. R. Harder, and K. E. Francis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Sci. Eng., 16: 12-24(May 1963).

Data obtained from studies of the electrophoretic mobility of thoria and plutonia suspensions were examined in relation to their dispersion and ion adsorption properties. Dispersion data in many cases bear out qualitatively the concept of a critical zeta potential below which flocculation of the suspension takes place, but exceptions to the rule were found in a number of electrolyte solutions. Adsorption isotherms obtained from tracer studies and direct analysis were compared with those calculated from electrophoretic data. Differences between ζ and ψ in the case of hydrogen ions are qualitatively consistent with adsorption on a negative site in the presence of a Stern-type layer of anions. Observations with I^-, CrO_4^{2-}, Cs^+, Sr^{2+}, Ce^{3+}, and Th^{4+} require a qualified interpretation, and reveal the danger of drawing quantitative conclusions from electrophoretic data unsupported by more direct measurements. (auth)

25216 INVESTIGATIONS ON THE GERMANATES AND SILICATES OF THE ABO_4 TYPE OF THE TETRAVALENT ELEMENTS FROM THORIUM TO AMERICIUM. Cornelius Keller (Technische Hochschule, Karlsruhe and Kernforschungszentrum, Leopoldshafen, Ger.). Nukleonik, 5: 41-8(Feb. 1963). (In German)

The reactions of the dioxides of elements from Th to Am with GeO_2 and SiO_2 were investigated by thermal and hydrothermal methods. In the thermal reaction of MeO_2 (Me = Th and Pa) with GeO_2, α-$MeGeO_4$ (Scheelite structure) is formed, and it is transformed at higher temperature into β-$MeGeO_4$ (zircon structure). UO_2, PuO_2, NpO_2, and AmO_2 react thermally and PuO_2 and AmO_2 also hydrothermally with GeO_2 with the formation of α-$MeGeO_4$. ThO_2, PaO_2, and UO_2 form with GeO_2 under hydrothermal conditions β-$MeGeO_4$. NpO_2 reacts with GeO_2 hydrothermally to form $(\alpha + \beta)MeGeO_4$. ThO_2 and PaO_2 react thermally with SiO_2 to form β-$MeSiO_4$ (huttonite structure). The dioxides of Th up to Am react hydrothermally with SiO_2 to form α-$MeSiO_4$ (zircon structure). Various mixed-crystal series of actinide germanates and silicates were prepared. The lattice constants, preparation conditions, and properties were determined. (tr-auth)

25217 MAGNETIC AND CRYSTAL STRUCTURE OF TITANIUM SESQUIOXIDE. S. C. Abrahams (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 130: 2230-7 (June 15, 1963).

A single-crystal neutron diffraction study was made of titanium sesquioxide in the temperature range 1.4 to 711°K. The crystal undergoes a transition at a temperature variously reported as about 450 to 600°K, below which the structure becomes antiferromagnetic. In the crystal studied, $T_N \approx 600$°K. The magnetic moments in this corundum-type structure have an arrangement similar to that in α hematite between 253 and 948°K. Puckered sheets of Ti^{3+}, parallel to (111), are ferromagnetic with moments lying in the plane normal to the trigonal axis. Adjacent cation sheets, separated by a layer of oxygen, have antiparallel moments. The magnitude of the moment is about 0.2 μB per Ti^{3+}. There is no evidence for a moment parallel to the trigonal axis. The magnetic form factor increases with scattering angle, due to some unquenched orbital momentum. An explanation for the observed form factor and for the moment perpendicular to [111] was given by Blume. The density maxima of antiparallel pairs of moments are displaced toward each other along the trigonal axis. (auth)

25218 COMMENTS ON SPIN-LATTICE RELAXATION. D. E. McCumber (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 130: 2271-6(June 15, 1963).

Microscopic interpretations of an experiment measuring the temperature dependence of spin-lattice relaxation in rare-earth salts are discussed with the aid of a systematic general formalism. The discussion clarifies the relation between two-step phonon relaxation processes and resonant phonon-scattering processes, both of which were proposed in the literature, to explain the experimental results. It is shown that a complete treatment of the two-step process — that is, a process involving two consecutive single-phonon direct processes — includes the results previously ascribed to resonant scattering processes and in addition gives small corrections to the results. (auth)

25219 NUCLEAR MAGNETIC RESONANCE OF Xe^{129} IN NATURAL XENON. E. R. Hunt and H. Y. Carr (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 130: 2302-5 (June 15, 1963).

Nuclear magnetic resonance studies of natural xenon

were continued using fluid samples with improved purity. The Xe^{129} spin-lattice relaxation time in the gas was found to be inversely proportional to the density. For the liquid in equilibrium with its vapor, the relaxation time throughout the temperature range 0 to −72°C is 1000 ± 200 sec. In both the gas and the liquid the paramagnetic shift in the resonant value of the local field H at the nucleus, relative to its value for the isolated atom in the same external field, is directly proportional to the density and the external field. The spin-lattice relaxation time and ΔH data agree well with a relationship derived by Torrey involving an analysis of the fluctuating magnetic field at a nucleus due to the rotation of a diatomic configuration. The derivation is based on Ramsey's theory of the chemical shift and the spin-rotational coupling that exist when two atoms are sufficiently close to interact. (auth)

25220 CHEMICAL SHIFT AND RELAXATION OF Xe^{129} IN XENON GAS. H. C. Torrey (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 130: 2306-12(June 15, 1963).

The density-proportional chemical shift observed in xenon gas can be used as a means of calibrating the spin-rotational coupling existing in a diatomic xenon system during collisions of xenon atoms. The basis of this calculation is Ramsey's theory of chemical shifts. The value of the coupling thus obtained is of the correct magnitude to account for the observed relaxation of Xe^{129} in xenon gas. (auth)

25221 FIELD DEPENDENCE OF THE DIRECT-PROCESS SPIN-LATTICE RELAXATION TIME IN RARE-EARTH SALTS. D. Huber (Harvard Univ., Cambridge, Mass.). Phys. Rev., 131: 190-7(July 1, 1963).

The field dependence of the direct-process spin-lattice relaxation time for rare-earth salts having $g_\perp = 0$ is computed taking into account dipolar coupling between the spins. Comparison is made with the corresponding relaxation time calculated in a modified effective-field approximation, and the presence of terms not found in the modified effective-field formula is noted. Conditions that must obtain for the effective-field approximation to be valid are discussed, and a numerical evaluation of the relaxation time for dysprosium ethyl sulfate is given. Extension of the calculation to salts not having $g_\perp = 0$ is also considered. (auth)

25222 ELECTRONIC POLARIZABILITIES AND STERNHEIMER SHIELDING FACTORS. R. E. Watson (Atomic Energy Research Establishment, Harwell, Berks, Eng. and Bell Telephone Labs., Murray Hill, N. J.) and A. J. Freeman. Phys. Rev., 131: 250-5(July 1, 1963).

A new method is developed for determining the distortions induced in electronic distributions by valence electrons and/or crystalline fields and their effect on magnetic and electric hyperfine interactions. For illustrative purposes emphasis is placed on the calculation of Sternheimer antishielding factors. Working within the framework of the Hartree-Fock self-consistent formalism, it is shown that the angular excitations are obtained by relaxing the usual restriction that the spatial part of the one-electron functions be separable into a radial function times and angular function; relaxing the restriction that electrons of the same shell but differing in magnetic quantum number have the same radial function yields the radial excitations. To illustrate the method, calculations are reported for several spherical ions (Cl^- and Cu^+) in an external field, but the scheme is also applicable to the problem of induced electric quadrupole and magnetic dipole and higher multipole distortions of an ion by its own aspherical charge distribution. The problems of orthogonality, exchange, and self-consistency, that have complicated applications of the perturbation method are easily resolved by this approach. Further, since a self-consistent field procedure is followed, the distortions induced in the inner closed shells by the distorted outer shells are included in a natural way and by comparison with the results of the perturbation-variation method these additional effects are shown to be significant. (auth)

25223 ELECTRONIC RAMAN EFFECT IN Pr^{3+} IONS IN SINGLE CRYSTALS OF $PrCl_3$. J. T. Hougen and S. Singh (National Research Council, Ottawa). Phys. Rev. Letters, 10: 406-7(May 1, 1963).

The energy levels of Pr^{3+} ions in single crystals of $PrCl_3$ were studied by means of the Raman effect. At room temperatures five Stokes and five anti-Stokes Raman lines with frequency shifts less than 250 cm^{-1} were observed. The frequencies and polarization of these lines are presented. The polarization of the Raman lines are consistent with those calculated from the known crystal quantum numbers of the levels. (C.E.S.)

25224 ELECTRICAL CONDUCTIVITY OF A METAL DISSOLVED IN A MOLTEN SALT. E. G. Wilson (Univ. of Chicago). Phys. Rev. Letters, 10: 432-4(May 15, 1963).

A physical assumption concerning the role of the lattice order in electron scattering, together with a method for liquid metals, was used to calculate the resistivity of an alkali metal dissolved in a molten alkali halide in the region of small metal concentrations. The valence electrons of the added metal become the conduction electrons of the system. Data for K in molten KBr and KI were presented. (C.E.S.)

25225 THE CONFIGURATION OF THE ANION IN $CsReCl_4$. Ward T. Robinson, J. E. Fergusson, and Bruce R. Penfold (Univ. of Canterbury, Christchurch, N. Z.). Proc. Chem. Soc., 116(Apr. 1963).

An x-ray analysis was carried out on the compound of empirical composition $CsReCl_4$. The crystals are orthorhombic with a space group Ama2. There are 12 $CsReCl_4$ units in the unit cell of dimensions a = 10.66, b = 14.08, and c = 14.02 Å. The $[ReCl_4]^-$ anion is trimeric with a triangle of bonded Re atoms. The bond lengths are: Re-Re = 2.50 Å, Re-Cl (bridging) = 2.43 Å, Re-Cl (terminal in plane of Re atoms) = 2.60 Å, and Re-Cl (terminal off plane of Re atoms) = 2.35 Å. (D.L.C.)

25226 THERMODYNAMICS AND STRUCTURES OF MOLTEN SALTS. H. Flood (Norges Tekniske Høgskole, Trondheim, Norway). Pure Appl. Chem., 5: 529-41(1962). (In English)

A review is presented of the thermodynamic contributions to the knowledge of the structure of molten salts and of the applicability of structural models in thermodynamic calculations. One-component salt melts, salt mixtures with a common ion, and salt mixtures without a common ion are considered individually. (D.L.C.)

25227 TERNARY SPECIES AT HIGH TEMPERATURES. P. W. Gilles (Univ. of Kansas, Lawrence). Pure Appl. Chem., 5: 543-56(1962). (In English)

The physical-chemical principles involved in studies of vaporization processes are discussed. The different ways in which inorganic ternary gaseous species may be produced are described. The present state of knowledge of ternary gaseous species is summarized, and a table of ternary gaseous species is given. (D.L.C.)

25228 THE COORDINATION CHEMISTRY OF 3d TRANSITION METAL IONS IN FUSED SALT SOLUTIONS. D. M. Gruen and R. L. McBeth (Argonne National Lab., Ill.). Pure Appl. Chem., 6: 23-47(1963). (TID-15293)

A review is presented of the spectroscopic studies of 3d transition metal ions and their complexes in chloride melts. An interpretation of the spectra on the basis of crystal field theory is given with criteria for selection of suitable host crystal lattices. A correlation of the results with electrostatic energies and crystal field stabilization energies is given. (D.L.C.)

25229 FAST ELEMENTARY STEPS IN CHEMICAL REACTION MECHANISMS. M. Eigen (Max-Planck-Institut für Physikalische Chemie, Göttingen, Ger.). Pure Appl. Chem., 6: 97-115(1963). (In English)

A review is presented of studies of fast chemical reaction steps which were studied using various relaxation techniques. These studies include ligand substitution in metal complexes, proton transfer, and enzymatic hydrolysis. (D.L.C.)

25230 SOLUBILITY CONSTANTS OF METAL OXIDES, METAL HYDROXIDES AND METAL HYDROXIDE SALTS IN AQUEOUS SOLUTION. W. Feitknecht and P. Schindler (Universität, Bern). Pure Appl. Chem., 6: 130-99(1963). (In English and German)

A critical compilation of solubility data on oxides, hydroxides, and hydroxide salts is presented. The literature up to 1957 and, as far as possible, since 1957 is covered. The methods used in deriving the solubility constants are discussed. A bibliography of 146 references is included. (D.L.C.)

25231 DISTRIBUTION OF RADIOACTIVE CESIUM BETWEEN CRYSTALLINE PHASE OF POTASSIUM ALUMS AND SOLUTION. N. B. Mikheev and V. Pettsol'ts. Radiokhimiya, 5: 22-8(1963). (In Russian)

An attempt was made at finding the crystallization coefficient for cesium alum. Isothermal saturation does not lead to thermodynamic equilibrium in the examined $(K,Cs)Al(SO_4)_2^{1}/_{2}12H_2O$ aqueous solution because of the peculiarity of alum crystallization and delayed cesium adsorption equilibrium. The co-crystallization coefficient of initial cesium adsorption on alum was equal to 20. The adsorption equilibrium is reached within 16 to 20 hours. The crystallization coefficient is confirmed by experiments using logarithmic co-crystallization of cesium with alum. The maximum λ is equal to 19. (R.V.J.)

25232 CONCENTRATION OF PROTACTINIUM IN HIGH-SILICIC ACID MATERIALS. R. A. D'yachkova and Vikt. I. Spitsyn. Radiokhimiya, 5: 106-10(1963). (In Russian)

Co-precipitation of protactinium in fluoride complex solutions with low-solubility fluorides and fluosilicates was studied. Lead, strontium, and calcium fluorides precipitate protactinium in solutions free of fluosilicic acid. The co-precipitating ability of fluosilicates is according to the following order: Na_2SiF_6, K_2SiF_6, and $BaSiF_6$. (R.V.J.)

25233 COMPLEX FORMATION OF URANYL ION WITH CERTAIN SCHIFF BASE REAGENTS. L. N. Pankratova, I. A. Savich, and A. V. Lapitskii. Radiokhimiya, 5: 114-18 (1963). (In Russian)

Stability constants for complex compounds formed by salicylalamine pyridine and its halogen derivatives and UO_2^{2+} were found. The influence of replacing components on the acid constants in Schiff base dissociation and on stability constants in formed complex compounds was determined. (R.V.J.)

25234 XENON OXYFLUORIDE. D. F. Smith (Oak Ridge Gaseous Diffusion Plant, Tenn.). Science, 140: 899-900(May 24, 1963). (TID-18380)

The incomplete hydrolysis of XeF_6 was used to prepare a xenon oxyfluoride, $XeOF_4$. The latter is a clear, colorless liquid, freezing at -41°C. The infrared and Raman spectra show that the $XeOF_4$ molecule has a fourfold symmetry axis. The large Xe-O stretching force constant indicates the Xe-O bond has appreciable double bond character. (auth)

25235 COPRECIPITATION WITH URANIUM(IV) OXALATE. Jacob Block and Louis Gordon (Case Inst. of Tech., Cleveland). Talanta, 10: 351-65(Apr. 1963). (In English)

The coprecipitation of cerium(III) with uranium(IV) oxalate is studied using dimethyl oxalate to precipitate uranium(IV) from homogeneous solution. A limited study is also made using scandium(III) and uranium(IV). These systems obey the logarithmic distribution law more closely than the homogeneous distribution law. The distribution coefficient is found to be functionally related to the experimentally determined first-order precipitation rate constants when a trace quantity of cerium(III) is coprecipitated with carrier uranium(IV) oxalate. The coefficient λ is found to be equal to K_T/K_C where K_T, the fractional rate of precipitation of tracer, is determined in the presence of the carrier. The cerium(III)-uranium(IV) oxalate system obeys a distribution law modified to include ion charge rather than the unmodified Doerner-Hoskins logarithmic distribution law. (auth)

25236 RAMAN INTENSITIES. PART 9. VIBRATIONAL INTENSITIES FOR SPHERICALLY SYMMETRIC MODES OF CH_4, CD_4, CF_4, SiF_4, SF_6, SeF_6 AND TeF_6. D. A. Long and E. L. Thomas (University Coll. of Swansea, Eng.). Trans. Faraday Soc., 59: 1026-32(May 1963).

Measurements of the vibrational Raman intensities for the $\nu_1(\alpha_1)$ modes of CD_4, CF_4, SiF_4, SF_6, SeF_6, and TeF_6 (all in the gaseous state) relative to the $\nu_1(\alpha_1)$ mode of CH_4 are reported. Values of derived bond polarizabilities are calculated and discussed. (auth)

25237 FORCE CONSTANT STUDIES. PART 8. IN PLANE VIBRATIONS OF NH_2CH, ND_2CN AND NHDCN. D. A. Long and D. T. L. Jones (University Coll. of Swansea, Eng.). Trans. Faraday Soc., 59: 1033-8(May 1963).

Assignments for the in-plane vibrations of NH_2CN and ND_2CN are reviewed, and a model is proposed. A form of valence field with 10 force constants is found to be satisfactory. Using a computer program, values of the ten constants are obtained that reproduce all the in-plane frequencies in NH_2CN and ND_2CN with an average error of 0.47%. The values of the force constants indicate that the double-bond character in the H_2N-CN bond is not as high as has been suggested. The fundamental frequencies of NHDCN are predicted. (auth)

25238 LIQUID-PHASE THERMAL CONDUCTIVITIES OF ISOTOPICALLY SUBSTITUTED MOLECULES. J. K. Horrocks, E. McLaughlin, and A. R. Ubbelohde (Imperial Coll. of Science and Tech., London). Trans. Faraday Soc., 59: 1110-13(May 1963).

The thermal conductivities of liquid benzene, perdeuterobenzene, cyclohexane, and perdeuterocyclohexane are determined between 20 and 75°C. These results are discussed in terms of the mechanism of transport in the liquid phase. (auth)

25239 ENTHALPY OF HYDRATION OF THE PROTON. H. F. Halliwell and S. C. Nyburg (Keele Univ., Eng.). Trans. Faraday Soc., 59: 1126-40(May 1963).

A method is presented for estimating the absolute hydration enthalpy of the proton at infinite dilution and at 298°K. The method makes use of a simple model of aqueous solu-

tions, and is based on the significance of differences between thermodynamic hydration functions for ions of opposite charge. Values of the differences between conventional hydration enthalpies are plotted against $(R + \alpha)^{-3}$, where R is the effective radius of the ion and α is the effective radius of the water molecule. This plot yields the absolute hydration enthalpy of the proton. The value obtained is -260.7 kcal mole^{-1} with an estimated uncertainty of ± 2.5 kcal mole^{-1}. An estimate of the quadrupole moment of the water molecule is also made. (auth)

25240 DISSOCIATION CONSTANTS OF FORMIC ACID AND FORMIC ACID-d. R. P. Bell and W. B. T. Miller (Oxford Univ.). Trans. Faraday Soc., 59: 1147-8(May 1963).

It is shown by conductivity measurements that DCO_2H has a smaller dissociation constant than HCO_2H in aqueous solution. The observed difference, $\Delta pK = 0.035 \pm 0.002$, agrees with a theoretical calculation of the secondary isotope effect. (auth)

25241 SOME REACTIONS OF CYCLOHEXENE WITH HYDROGEN AND DEUTERIUM ON EVAPORATED GOLD FILMS. J. Erkelens, C. Kemball, and A. K. Galwey (Queen's Univ., Belfast). Trans. Faraday Soc., 59: 1181-91(May 1963).

The reactions of cyclohexene with hydrogen or deuterium on gold films are investigated using a mass spectrometer to analyze the products. Reactions of cyclohexene and hydrogen between 196 and 342°C yield cyclohexane and benzene, the proportion of the latter increasing with temperature. Activation energies for the reactions are determined, and the kinetics that show some complex features are examined at 246°C. A simple exchange reaction occurs with cyclohexene and deuterium in the range 150 to 240°, and small amounts of cyclohexanes, initially mainly cyclohexane-d_0, are produced. The mechanisms of the reactions are discussed in terms of an approximate energy level diagram for the various reaction paths. Gold appears to be a relatively effective catalyst for the dehydrogenation of cyclohexene but a poor catalyst for hydrogenation of the olefin, chiefly because the frequency factor of the addition reaction is low. (auth)

25242 A CONTRIBUTION ON THE KINETICS OF CARBIDE FORMATION IN CHROMIUM STEEL. Walter Koch and Helga Kolbe-Rohde (Max-Planck-Institut für Eisenforschung, Duesseldorf). Z. Anorg. Allgem. Chem., 319: 312-19(Jan. 1963). (In German)

With increasing Fe content, an almost 1.4% decrease of the lattice constant a of hexagonal chromium carbide mixed crystals, $(Cr, Fe)_7C_3$, occurred, whereas the constant c remained nearly constant. The transformation of the γ-mixed crystals of chromium steels with more than 3% Cr yielded in the temperature range of 500 to 700°C, at first orthorhombic $(Fe,Cr)_3C$ which was consumed on longer heating by formation of the hexagonal carbide. This took up chromium from the Cr-containing α-Fe mixed crystals also present. (auth)

25243 RuO_2 CHEMICAL TRANSPORT, PROPERTIES, THERMAL DECOMPOSITION. Harald Schaefer, Gerd Schneidereit, and Wilfried Gerhardt (Universität, Munster, Ger.). Z. Anorg. Allgem. Chem., 319: 327-36(Jan. 1963). (In German)

The preparation of RuO_2 crystals by means of chemical transport is described. The lattice parameters of the tetragonal RuO_2 were found to be $a = 4.49 \pm 0.005$ and $c = 3.11 \pm 0.005$ Å. The specific conductivity determined with single crystals was $\varkappa = 2 \times 10^4$ ohm^{-1} × cm^{-1} at 20°C. The study of the equilibrium $RuO_2 = Ru + O_2$ by means of a glowing filament, with the thermo-balance, and by static pressure measurements indicated that the oxygen pressure is much lower than the coresponding literature data. The oxygen pressure of 1 atm is reached at 1580°C. The enthalpy of formation of RuO_2 is $\Delta H(298) = -71$ kcal/mol. (auth)

25244 HIGH-FREQUENCY TITRATION. COMMUNICATION 7. STUDY OF THORIUM CARBONATE COMPOUNDS. D. I. Ryabchikov, M. P. Volynets, V. A. Zarinskii, and V. I. Ivanov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 18: 348-56(Mar. 1963). (In Russian)

It was established by a method of high-frequency titration that Th forms complex compounds in solutions of alkaline metal and ammonium carbonates at a molar ratio of Th : CO_3^{2-} equal to 1 : 4. The complex anion is supposed to have a composition $[Th(CO_3)_4]^{4-}$, the Th coordination number being equal to 8. It was established by means of the thermogravimetric and x ray structural study of a solid 12-hydrous sodium carbonate–thorium complex that one of the five groups of CO_3^{2-} in the crystal structure of the complex determined by a chemical method is not connected with Th directly, and all the 12 molecules of water are water of crystallization. Thus the following crystallochemical formula is suggested for the Th carbonate complex: $Me_4[Th(CO_3)_4] \cdot Me_2CO_3 \cdot 12H_2O$ (Me = Na^+, K^+). The crystallographic characteristics for a nonhydrous and a 12-hydrous thorium–sodium carbonate complex are given. It was also established that when a Th nitrate solution is titrated with a solution of alkaline metal or ammonium carbonate complete Th precipitation takes place at a ratio of Th : CO_3^{2-} = 1 : 2. It is suggested that the precipitate is a normal Th carbonate $Th(CO_3)_2 \cdot nH_2O$. (auth)

25245 CO-EXISTENCE OF ANTIFERROMAGNETIC AND DIELECTRIC PROPERTIES IN $BiFeO_3$–$LaFeO_3$ SYSTEMS. Yu. E. Roginskaya, Yu. N. Venevtsev, and G. S. Zhdanov (Karpov Inst. of Physics, USSR). Zh. Eksperim. i Teor. Fiz., 44: 1418-20(Apr. 1963). (In Russian)

Dielectric, magnetic, and x-ray studies were made of $BiFeO_3$–$LaFeO_3$ systems in which $BiFeO_3$ is seignetto-antiferromagnetic and $LaFeO_3$ is antiferromagnetic with a weak ferromagnetic intensity. X-ray analysis at room temperature indicated a continuous series of solid solutions with perovskite structure. Magnetic measurements at room temperature to 500°C indicated singular magnetic properties. The specific magnetism in $BiFeO_3$–$LaFeO_3$ was studied as a function of temperature, and a phase diagram was constructed. Spontaneous magnetic intensity at 20°C as a function of composition was analyzed. (R.V.J.)

25246 KINETICS OF THE ANODIC OXIDATION OF NIOBIUM IN SOME ELECTROLYTES. A. Ya. Shatalov and T. P. Bondareva (Voronezh State Univ., USSR). Zh. Fiz. Khim., 37: 868-74(Apr. 1963). (In Russian)

Potential—time curves were obtained in the anodic oxidation of pure Nb in 1N sulfuric, hydrochloric, phosphoric, and nitric acid solutions employing an external current of density 0.5 to 250 μa/cm^2. The anodic oxidation rate in the initial stages has a constant value in conformity with the linear portion of the potential—time curves. The latter then bend towards the abscissa axis and in the steady state equilibrium sets in between the formation and dissolution of the oxide film. After reaching the stationary state the niobium potential is higher, the greater the anode current density. The equation $i = \sigma A \exp[(B_+ + \alpha)F]$ was obtained for the kinetics of the ionic oxidation process in the solutions. The constants A_+, B_+, and α have different values

for solutions of different composition. Assuming that the time dependence of the electrodic potentials of Nb in the absence of external current is due to local corrosion currents resulting from the interaction of Nb and H_2O and using the corresponding values for A_+ and B_+ the values for the self-diffusion rate of Nb for solutions of 1N H_2SO_4 and HCl were found to be of the order of 10^{-7} a/cm^2. (auth)

25247 PRECIPITATION OF SCANDIUM HYDROXIDE AND OXALATE. V. M. Shatskii, L. N. Komissarova, and V. I. Spitsyn. Zh. Neorgan. Khim., 7: 2294-8(Oct. 1962). (In Russian)

A quantitative precipitation of Sc was achieved by ammonium and sodium hydroxide solutions. Effective precipitation depends on the scandium concentration, the amount of ammonium and NaOH, and on the additional precipitator with NH_4Cl. The losses of scandium in the filter did not exceed 1 mg/l Sc_2O_3. Precipitation of scandium by oxalic acid in weak solution was carried out using Sc_2O_3 > 5 g/l; 97% separation was obtained. At large concentrations of Sc (50 to 100 Sc_2O_3 g/l) the precipitation is 99.6%. (R.V.J.)

25248 COMPOSITION AND THERMAL STABILITY OF AMMONIATED SCANDIUM HALIDES. I. V. Tananaev and V. P. Orlovskii. Zh. Neorgan. Khim., 7: 2299-2303(Oct. 1962). (In Russian)

Synthesis of $[Sc(NH_3)_5Cl]Cl_2$, $[Sc(NH_3)_3(H_2O)_2Cl]Cl_2 \cdot 2\,H_2O$, $[Sc(NH_3)_3(H_2O)_2Cl]Cl_2$, $ScCl_3 \cdot 4\,NH_3$, $ScCl_3 \cdot 2\,NH_3$ was obtained, and the thermal stability of the synthesized compounds was determined. Preparation of $ScBr_3 \cdot 4\,NH_3$, $ScBr_3 \cdot 2\,NH_3$, $[Sc(NH_3)_3(H_2O)_2Br]Br_2 \cdot 2\,H_2O_2$ is also described. Ammoniated scandium iodide decomposes with light. Scandium fluoride does not react with ammonium. (R.V.J.)

25249 THORIUM SALICYLATE. K. N. Kovalenko, D. V. Kazachenko, and E. M. Ivanova. Zh. Neorgan. Khim., 7: 2340-4(Oct. 1962). (In Russian)

Results of experiments with the aqueous thorium nitrate–sodium salicylate system indicated that an exchange reaction takes place at a thorium nitrate–sodium salicylate mole ratio of 1 : 2. The specific electroconductivity of pure thorium nitrate, 7.20×10^3, increased to 10.02×10^3 at a ratio of 1 : 2, decreased to 9.40×10^3 at 1 : 4, and then rose to 14.97×10^3 at 1 : 9. The curve for pH with increasing sodium salicylate concentration had a minimum at a ratio of 1 : 2. The thorium salicylate formed was difficultly soluble in water, readily soluble in alcohol, ether, and acetone, slightly soluble in dioxane, and insoluble in chloroform and carbon tetrachloride. When the thorium nitrate–sodium salicylate ratio in the reaction solution was 1 : 4 (pH 2.4), the salicylate readily precipitated as the anhydrous $ThO(C_6H_4OHCOO)_2$. However, with a ratio of 1 : 3 (pH 2.24), the precipitate formed only after several days and had the composition $ThO(C_6H_4OHCOO)_2 \cdot 3\,H_2O$. (TTT)

25250 COMPLEX FORMATION IN NIOBIUM(V)–SALICYLATE–ORGANIC BASE. A. K. Babko and A. I. Volkova (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zh. Neorgan. Khim., 7: 2345-51(Oct. 1962). (In Russian)

Physico-chemical studies of the yellow niobium salicylate system indicated that a complex anion of Nb : Sal = 1 : 2 ratio forms at pH 3. The equilibrium constant of the complex formation at pH 4 is: $K_{NbOSal_2^-} = [(NbO^{3+})(Sal)^{2-}]^2/(NbOSal_2^-) = 2.5 \times 10^{-23}$. Ternary niobium salicylate–organic base systems are extracted by chloroform. Systems with organic base of pyridine, quinoline, pyramidon, antipyrine, diantipyrilmethane, quinine, codeine, urothropine, triethylamine, and tetralin were studied. The ternary niobium complexing was studied as a function of the pH and reagent concentrations. Optimum conditions are at pH 2 to 3. Absorption spectra for the ternary complex chloroform extraction show two bands; salicylic acid band at λ = 315 mμ and niobium band at λ = 350 mμ. The latter is used in photometric niobium determination. (R.V.J.)

25251 REACTIONS OF NIOBIUM AND TANTALUM PENTACHLORIDES WITH POTASSIUM AND SODIUM CHLORIDES. A. P. Palkin and N. D. Chikanov. Zh. Neorgan. Khim., 7: 2394-9(Oct. 1962). (In Russian)

Phase diagrams of $NbCl_5$–$TaCl_5$–NaCl and $NbCl_5$–$TaCl_5$–KCl were constructed. Incongruently melting compounds of $NaNbCl_6$ and $NaTaCl_6$ polymorphous (α,β) modification form continuous solid solutions without maximums. Peritectic transformations in $TaCl_5$–NaCl (transition point at 48% NaCl) and $NbCl_5$–NaCl (transition point at 44% NaCl) continuously pass over into each other with temperature dropping from 484 to 444°. Congruently melting α-$NbCl_6$ and α-$KTaCl_6$ and their polymorphous β modifications form a continuous series of solid solutions, and the low-temperature polymorphous modifications γ $KTaCl_6$ and γ $KNbCl_6$ form continuous solid solutions with a minimum. The liquidus $NbCl_5$–$TaCl_5$–KCl systems consist of initial crystallization field KCl, solid solution $KTaCl_6$–$KNbCl_6$, and a very small solid solution field $TaCl_5$–$NbCl_5$. Irrespective of $TaCl_5$ and $NbCl_5$ ratios, lamination was not observed up to 40% KCl. Alloys adjacent to the NaCl and KCl peaks are high melting and those near $NbCl_5$ and $TaCl_5$ are low melting. (R.V.J.)

25252 THERMAL AND TENSIOMETRIC STUDIES OF $NbCl_5$–$AlCl_3$–KCl; $KNbCl_6$–$KTaCl_6$–$KAlCl_4$, AND $NbCl_5$–$KTaCl_6$–$KAlCl_4$. I. S. Morozov and V. A. Krokhin. Zh. Neorgan. Khim., 7: 2400-10(Oct. 1962). (In Russian)

Chemical reactions of Al, K, Nb and Ta during their crystallization in melts were studied. Constitution diagrams constructed for $KAlCl_4$–$KTaCl_6$, $KAlCl_4$–$KNbCl_6$ exhibited simple eutectic-type diagrams, the $KTaCl_6$–$KNbCl_6$ exhibited a continuous series of solid solutions, and $KTaCl_6$–$NbCl_5$ and $KAlCl_4$–$NbCl_5$ systems exhibited stratification regions in the initial $NbCl_5$ crystallization field. Diagrams were also constructed for the liquidus surfaces of quasi-ternary and ternary systems: $NbCl_5$–$AlCl_3$–KCl, $KNbCl_6$–$KTaCl_6$–$KAlCl_4$, and $NbCl_5$–$KTaCl_6$–$KAlCl_4$ and crystallization boundaries were determined. Tensiometric studies were made of the following systems: $NbCl_5$–$AlCl_3$–KCl, $NbCl_5$–$TaCl_5$–KCl, and $NbCl_5$–$TaCl_5$–$AlCl_3$–NaCl. (R.V.J.)

25253 SOLID SOLUTIONS IN NaOH–NaH AND KOH–KH SYSTEMS. V. I. Mikheeva and M. M. Shkrabkina. Zh. Neorgan. Khim., 7: 2411-8(Oct. 1962). (In Russian)

Pure hydrides are characterized by a sharply defined temperature at which thermal decomposition begins, 428°C for KH and 421°C for NaH. All hydrogen is released at these temperatures. The NaOH–NaH system decomposes before melting with more than 60% NaH in the mixture and the KOH–KH system likewise with more than 48% KH. Thermographs showed, with an increase in the concentration of the hydride, an increase in the melting temperature and a decrease in the temperature of polymorphic conversion of the initial hydroxides. Roentgen analysis showed formation of solid solutions. Peritectic diagrams show limited regions of solid solutions. Solid solutions are expected because NaOH above 299°C and KOH above 247°C are converted from alpha to beta modifications. At room temperature the region of homogeneity extends to 18% NaH in NaOH–NaH and to 14% KH in KOH–KH systems. The

homogeneous region broadens with increase in the temperature. By dissolving hydrides in hydroxides, their thermal stability is increased markedly and the temperature region of their application is broadened to 500 to 550°C. (TTT)

25254 DIAGONAL CROSS SECTIONS OF THE QUATERNARY RECIPROCAL SYSTEM CONSISTING OF THE PYROPHOSPHATES AND CHLORIDES OF LITHIUM, SODIUM, AND POTASSIUM. A. G. Bergman and V. P. Goryacheva (Kuban Agricultural Inst., USSR). Zh. Neorgan. Khim., 7: 2438-43(Oct. 1962). (In Russian)

Following previously reported studies (Zhur. Neorg. Khim., 7: 1394(1962)), 2 diagonal cross sections of the Li, Na, K::F, P_2O_7 system were investigated: the $Li_4F_4-Na_4P_2O_7-K_4P_2O_7$ and $K_4F_4-Li_4P_2O_7-Na_4P_2O_7$ areas, using visual and thermal methods. The first one contains the following limiting subsystems: $Na_4P_2O_7-K_4P_2O_7$, representing a continuous solid solution with a minimum at 40% $K_4P_2O_7$; $Li_4F_4-Na_4P_2O_7$, an unstable diagonal section of the Na, Li::F, P_2O_7 system; and $Li_4F_4-K_4P_2O_7$ a similarly unstable triangular diagonal of the same system. In the $Li_4F_4-Na_4P_2O_7-K_4P_2O_7$ ternary, 14 sections divided into 3 fields of $Li_4F_4-Li_4P_2O_7$ and solid solutions $(Na_4F_4)P_2O_7$ were examined. The $K_4F_4-Na_4P_2O_7$ system contains 4 crystallization areas, including the components, the reciprocal products of Na_4F_4, and the compound $xNa_4P_2O_7 \cdot yK_4P_2O_7$; the latter is a decomposition product of the solid solutions of the Na + K pyrophosphates. The $Li_4P_2O_7-Na_4P_2O_7$ system has a eutectic at 720°C and 38% $Li_4P_2O_7$. In the $K_4F_4-Li_4P_2O_7-Na_4P_2O_7$ system 15 sections were studied; they were found to consist of 6 fields which are joined in 4 monovariant points. (TTT)

25255 PREPARATION OF SULFUR DIOXIDE FOR ISOTOPIC ANALYSIS. V. A. Grinenko. Zh. Neorgan. Khim., 7: 2478-83(Oct. 1962). (In Russian)

Data obtained on S^{32}/S^{34} ratios by mass spectrographic analysis of SO_2 released from minerals by oxidation of sulfur showed a precision of ±0.02%. The method, which consists in converting the sulfur in the mineral to SO_2 by reaction with CuO in a vacuum at 770 to 810°C, was applied to pyrite (FeS_2), pyrrhotine (Fe_mS_n), chalcopyrite ($FeCuS_2$), sphalerite (ZnS), and galenite (PbS). Oxidation started at 350 to 500°C and stopped at 770 to 810°C, and required 20 to 30 min. The SO_2 was 98 to 100% released, thus eliminating the possibility of fractionation of the isotopes. Excess oxidant was needed only for galenite. The standard used in the mass spectrograph for comparison was meteoric ferrous sulfide (troilite). A sketch of the apparatus used is shown. A table is given to show the variation in the S^{32}/S^{34} ratio with the amount of SO_2 released from the mineral. The lighter isotope is more abundant in the first portion. (TTT)

25256 KINETICS OF NIOBIUM CARBIDES AND NIOBIUM OXIDES REACTION IN A VACUUM. G. P. Shveikin and V. D. Lyubemov. Zh. Prikl. Khim., 36: 299-307(Feb. 1963). (In Russian)

Kinetic characteristics of niobium oxide and carbide reactions ($NbC + 2NbO_2 = 3NbO + CO$, $Nb_2C + NbO = 3Nb + CO$, and $5NbC + NbO_2 = 3Nb_2C + 2CO$ at 1400 to 1700°C) showed that the rate of the process is a function of the size of components, compression, and gas evacuation rate. Kinetic difficulties were encountered during metallic niobium formation. Sintering and gas evacuation play an important part along with the diffusion process. (R.V.J.)

25257 THE INFLUENCE OF B_2O_3 ON FORMATION AND PHYSICO-TECHNICAL PROPERTIES OF THE SOLID SOLUTIONS $SrTiO_3-SrZrO_3$. Kh. Sh. Iskhakov and E. K. Keler (Grebenshchikov Inst. of Silicate Chemistry, USSR). Zh. Prikl. Khim., 36: 480-9(Mar. 1963). (In Russian)

Effects of boric acid anhydride on the formation and physico-technical properties of solid solutions of $SrTiO_3-SrZrO$ were studied. Small admixtures of B_2O_2 reduce the sintering temperature. A mechanically strong, low-porosity strontium titanate and zirconate ceramic was prepared with $2SrO \cdot B_2O_3$ mineralizer at 1450°C. (R.V.J.)

25258 EXPERIMENTAL DETERMINATION OF THE ELECTROCONDUCTIVITY OF LIQUID SODIUM, POTASSIUM, AND LITHIUM. A. N. Solov'ev. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 1, 158-60(Jan.-Feb. 1963). (In Russian)

Results are presented concerning the measurement of the electroconductivity of molten lithium, sodium, and potassium as a function of the temperature. The measurements for lithium and sodium were carried out from 100 to 1000°C, while the potassium determinations were made only up to 730°C. The data obtained, as well as results from other investigators, are displayed on a graph of conductivity plotted versus temperature. In some temperature intervals agreement with earlier results is noted; in other temperature ranges there is disagreement. The error involved in these measurements is estimated to be 2.5%. The average scatter of the experimental points was found to be 0.3% for sodium, 0.5% for potassium, and 0.8% for lithium. The greatest number of determinations were carried out for sodium and, using the method of least squares, an interpolation formula was derived for the electroconductivity of sodium as a function of temperature. (TTT)

25259 STRUCTURAL PECULIARITIES OF CERTAIN COMPLEX RUTHENIUM AND OSMIUM COMPOUNDS. E. M. Shustorovich (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Strukt. Khim., 4: 245-9(Mar.-Apr. 1963). (In Russian)

A method of molecular orbits was used in the investigation of structures of Ru and Os compounds. It was observed that under identical conditions of bonding the valency of allied metal atoms varies. Such conditions lead to variable magnitudes in destabilizing $p_\pi - d_\pi$ interactions between free electrons of alloying materials and central atom. Thus, an ordinary molecular orbit method was modified to meet the necessary conditions and stereochemical peculiarities of the examined complexes were interpreted on the basis of the obtained data. (tr-auth)

25260 THERMODYNAMIC CHARACTERISTICS OF STRUCTURAL CHANGES IN WATER RELATED TO THE HYDRATION OF CERTAIN IONS OF RARE EARTHS AND ACTINIDES. G. A. Krestov (Ivanov Chemical Technological Inst., USSR). Zh. Strukt. Khim., 4: 263-5(Mar.-Apr. 1963). (In Russian)

Thermodynamics of structural variations in water related to hydration of certain simple ion rare earths and actinides were studied. Entropy variations in a simple ion hydration were calculated as the difference between ion entropy in a solution or in a gaseous state. Numerical entropic values and crystalline radii for tri- and tetra charged rare earths and actinides are tabulated. The effect of water molecule ordering at the expense of their orientation in the ion field prevails over the displacement effects caused by mutual disordering of water molecules. An increase of the absolute value AS_{II}, related to the increase of ion potentials at the expense of reduced radii, was observed in transitions of La^{3+} to Lu^{3+}, Ac^{3+} to Mv^{3+} and Th^{4+} to Mv^{4+}. (R.V.J.)

25261 EFFECTS OF HEAVY WATER ON CHEMICAL SHIFT OF F^{19}. P. M. Borodin, E. K. Legin, E. N.

Sventitskii, M. B. Khusidman, and V. A. Shcherbakov (Leningrad State Univ.). Zh. Strukt. Khim., 4: 266-7 (Mar.-Apr. 1963). (In Russian)

A spectrometer side band method was used for measuring magnitudes of δ fluoride chemical shifts in KF and HF–H_2O–D_2O. (R.V.J.)

25262 CRYSTALLINE STRUCTURE OF $K_4[Th(SO_4)_4(H_2O)_2]$. E. G. Arutyunyan and M. A. Porai-Koshits (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Strukt. Khim., 4: 276-7 (Mar.-Apr. 1963). (In Russian)

An x-ray structural analysis of $K_4[Th(SO_4)_4(H_2O)]$ was made considering that Th coordination polyhedrons are similar to that of thiocyanate compounds. The ziz-zag shaped chain of $[Th(SO_4)_4(H_2O)_2]^{4-}_{\infty}$ extended along the x axis and parallel to the (010) plane was separated. The Th atoms were bound to all four sulfate groups and to two molecules of water, but the sulfate groups differed in their bond. Two of them were bound to one atom with one being monogenic when the other was bigenic; the two others acted as a bridge binding Th atoms into a chain. The Th–H_2O distances were 2.20 to 240Å, Th–H_2O was 2.5Å, and S–O(in the SO_4^{2-} group) was 1.45 to 1.55Å. (R.V.J.)

25263 BINARY URANIUM, TANTALUM, AND TIN OXIDES. V. K. Trunov, Yu. P. Simanov, and L. M. Kovba (Moscow State Univ.). Zh. Strukt. Khim., 4: 277-9 (Mar.-Apr. 1963). (In Russian)

Structures of binary U, Ta, and Sn oxides were studied at 1200 to 1800°C. The results of x-ray phase analysis of annealed specimens were tabulated. The results of indexed x-ray pictures of $UTa_3O_{10.7}$ showed a structural similarity to UV_3O_{10}. The intensity lines of $UTaO_{5.17}$ are indexed assuming a rhombic (pseudohexagonal) subnucleus with a = 6.450, b = 3.772, and c = 3.972 kX. The superstructure lines indicated the U and Ta atom distribution order. The SnO_2–Ta_2O_5 and SnO_2–WO_3 systems did not form compounds at temperatures to 1200°C. A variable composition $2SnO \cdot Ta_2O_5$–$3SnO \cdot Ta_2O_5$ with pyrochlore structure and elementary nucleus with a = 10.542 ± 0.003 kX for the $Sn_2Ta_2O_7$ and a = 10.586 ± 0.003 kX for the $Sn_3Ta_2O_8$ were observed. A phase resembling the composition $SnTa_4O_{11}$ was observed with larger contents of Ta_2O_5. (R.V.J.)

25264 KHIMIYA RASTVOROV REDKOZEMEL'NYKH ELEMENTOV. RABUTY PO KHIMII RASTVOROV I KOMPLEKSNYKH SOEDINENII. (Chemistry of Rare Earth Solutions. Data on Chemical Solutions and Complex Compounds). Kiev, Publishing House of the Academy of Sciences, 1962. 192p.

A survey is given of properties of basic rare earth chlorides and hydroxides and of the extraction and complex formation of rare earth compounds. Complex formations of rare earths with oxycarbonic acids and with gluconic acids are discussed. Rare earth separation by ion exchange and chromatographic methods and complexing of rare earths with salicylic acid are also discussed. (R.V.J.)

25265 HET SYSTEEM NIOBIUMPENTACHLORIDE–NIOBIUMPENTOXIDE. (The System Niobium Pentachloride–Niobium Pentoxide). Wim 'T Hart. Thesis, Delft, Netherlands, Technische Hogeschool, 1962. 75p.

The binary system niobium pentachloride–niobium pentoxide and the dissociating compound niobium oxytrichloride, occurring in that system, were studied in order to obtain a better understanding of the reactions occurring during the chlorination of niobium ore concentrates. A critical review of the literature on the binary system is first given. The measurement of the vapor pressure of the several equilibrium curves is described. The vapor pressures were measured with a static method, using a glass sickle gage. The least-squares method was used to calculate the vapor pressure equations. The determination of the partial pressure of $NbOCl_3$ of the three-phase equilibrium S_{NbOCl_3}–$S_{Nb_2O_5}$–G is then described. A study is made of the occurrence of compounds in the binary system $NbCl_5$–Nb_2O_5. The Bakhuis-Roozeboom space model for the binary system is given. The thermodynamic potential of $NbOCl_{3_g}$ is calculated from the equilibrium constant of the equilibrium 5 $NbOCl_{3_g} \rightleftharpoons 3\ NbCl_{5_g} + Nb_2O_{5_s}$. (J.S.R.)

25266 DETERMINATION OF ELECTRONIC ENERGY LEVELS OF MOLECULES BY LOW ENERGY ELECTRON IMPACT SPECTROSCOPY. Lionel Mischa Raff. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 114p.

An electron impact spectrometer was designed, constructed, and employed to measure the energies of excited electronic states of molecules. Incident energies between 25 to 75 v were used, and the scattered electrons were electrostatically analyzed by a retardation method to obtain the spectra. Electron impact spectra for helium and argon were obtained for electron beams in the energy range from 25 to 50 ev. The levels agreed well with the optical determinations to within ±0.2 ev. The spin-forbidden transitions were as prominent as the spin-allowed ones. The spectrum of molecular hydrogen was obtained with a 60 ev beam. Spin-forbidden transitions were again observed. The spectrum of ethylene at 40, 50, and 75 ev was determined. Here, in addition to the optically allowed transitions, optically forbidden ones peaking at 4.6 and 6.4 ev were seen. The first value agrees with Evans's and the second with Potts's values for ethylene obtained by optical methods. The decrease of the intensity of the first transition peak with beam energy indicated that it corresponded to the T ← N transition as recently suggested by Evans and Mulliken. However, the lack of decrease of the 6.4 peak with increasing beam energy suggested that this peak is probably not a spin-forbidden transition, in disagreement with Mulliken's suggestion that it might be due to a Rydberg triplet state. Instead it appears to be due to an angular momentum or symmetry forbidden transition. The spectrum of water at 30 ev was obtained. A state at about 4.0 ev was observed, probably a low-lying triplet state. The strong singlet-triplet transitions observed throughout this work with electron beam energies as high as 50 ev above the transition energies indicated that the cross section for exchange scattering does not fall off with increasing incident beam energies as rapidly as calculated. Suggestions for improvements of the apparatus are given. (Dissertation Abstr. 23: May 1963)

25267 THE RAMAN SPECTRA OF SELECTED MOLECULES AT ELEVATED TEMPERATURES. Gene Joseph Pontrelli. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 100p.

A study was made of the Raman spectra of zirconium tetrachloride and hafnium tetrachloride at temperatures above 500°C and corresponding pressures of approximately 25 atm. Preliminary results were also obtained for the hexachlorozirconate ion as prepared by addition of zirconium tetrachloride to an alkali-chloride eutectic melt. The samples were sealed off under vacuum in otherwise conventional Raman tubes made from relatively heavy-wall (2 mm) fused silica. The tubes were enclosed in a vertical copper cell, maintained at the desired temperature by cartridge heaters, provided with a narrow slot for admission of the exciting radiation. Quartz windows were used at the slot and at the bottom of the cell to minimize con-

vection effects. The cell was enclosed by an insulating jacket with an inserted Vycor window. The preparation of all samples studied was complicated not only by the expected reaction with residual traces of water in the tubes, but also by thermal decomposition resulting in the formation of dark, non-volatile lower chlorides. Mechanical segregation of the contaminants proved satisfactory in the case of the tetrachlorides of zirconium and hafnium, but was only marginally successful in the case of the alkali-chloride melt. The Raman spectra were excited by mercury λ 4358. The results obtained for zirconium tetrachloride and hafnium tetrachloride are consistent with the assumption of T_d symmetry. The value of ν_3 for the tetrachlorides of zirconium and hafnium agrees with that obtained in the infrared studies of Buchler and Wilmhurst, while the values of ν_2 and ν_4 for zirconium tetrachloride confirm the predictions made by Wilmhurst based on the observation of combination bands. The observed value of ν_1 for zirconium tetrachloride is somewhat lower than that observed by Delwaulle. On the basis of a Urey-Bradley force field, the four force constants K, H, F', F (in 10^5 dynes/cm) for zirconium tetrachloride are (2.30, 0.012, −0.005, 0.164) and (2.43, 0.021, −0.016, 0.147) for hafnium tetrachloride. Second-order Raman lines of relatively high intensity were also observed and assigned to overtone and combination transitions. The same observations were made in the case of titanium tetrachloride and stannic tetrachloride at temperatures above 300°C. On the basis of these observations and those made for molecules at room temperature, it was concluded that the matrix element for the summation band transition is less than or equal to the corresponding matrix element for the difference band, depending on the extent of the electrical and mechanical anharmonicity. Three Raman bands were observed for the hexachlorozirconate ion at 675°C; a broad and intense band at $\Delta\nu$ = 323 cm^{-1} (ν_1), a very broad and intense band extending from $\Delta\nu$ = 114 to 118 cm^{-1} (which is considered to include ν_2 = 170 cm^{-1} and ν_5 = 132 cm^{-1}), and a weak band at $\Delta\nu$ = 263 cm^{-1} ($2\nu_5$). On the basis of a valence force field, the remaining three fundamental frequencies in cm^{-1} can be calculated to be ν_3 = 246, ν_4 = 120, ν_6 = 94. (TCO)

25268 SPECTRAL STUDIES OF THE URANYL ION. William Charles Neely. Thesis, Baton Rouge, La., Louisiana State Univ., 1962. 107p.

The spectral properties of the uranyl ion, UO_2^{++}, were investigated. Analyses of the phosphorescence fine structure of a number of uranyl compounds were done and satisfactory assignments of the principal bands made in terms of combinations of the fundamental modes of the uranyl entity. The phosphorescence lifetime of uranyl was established to be on the order of 10^{-4} seconds and was shown to be relatively independent of surrounding molecular structure. A valid spectrochemical series of ligand nucleophilicity was obtained from measurements of the (O,O) emission bands in a series of uranyl compounds. A semi-empirical equation for the prediction of U−O bond distances was investigated and found to produce reasonable results upon comparison with experimental values. A valence force field treatment of the uranyl group was made assuming a linear geometric configuration and the predicted ratio of the symmetric and asymmetric stretching frequencies found to agree with experimental values. Analyses of uranyl excitation spectra by the method of spacings indicated the presence of several electronic transitions having superposed vibrational structure. Studies of relative polarizations of electronic bands support the predicted nature of these transitions. (Dissertation Abstr. 23: May 1963)

25269 MASS SPECTROMETRIC STUDIES OF THE STABILITIES OF GASEOUS ALKALINE EARTH MONOFLUORIDES. Gary Duane Blue. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 149p.

A high-resolution, high-sensitivity mass spectrometer was constructed for application to high temperature thermochemical problems. It was a single focusing, 60° sector, 12 in. radius of curvature instrument having differential pumping for the analyzer, ion source, and oven regions. The high temperature source consisted basically of a tantalum Knudsen cell. The temperature of the cell was measured with an optical pyrometer. The effusing atoms and molecules passed through collimating slits to the ionization chamber where they were bombarded with electrons of controlled energy and ionized. The resulting ions were focused and collimated in the ion source and then mass analyzed by passing through the field of a 60° sector magnet. A sixteen stage electron multiplier employing 97% Ag−3% Mg alloy dynodes was used for ion detection. The multiplier made possible the measurement of ion currents as low as 10^{-19} amp. The instrument was also equipped with a collector which could be used to detect ions of intensity greater than 2×10^{-15} amps and provided a means for direct measurement of the gain of the multiplier for high-intensity ion beams. Experimental data were obtained by utilizing the apparatus to analyze the vapors effusing from a heated tantalum Knudsen cell containing an alkaline earth fluoride salt with aluminum present as a reducing agent. Ionization efficiency curves were obtained and temperature studies were made to determine the molecular precursor of the ions observed. Pressures of the gaseous species used in the equilibrium constants for the various reactions were calculated by making use of the ion current-pressure relationship $P = kI^+T$. The values of the equilibrium constants at different temperatures were then used together with free energy functions to calculate third law heats of reaction at 298°K. The measured heats of the reaction at 298°K for the homogeneous reactions M(g) + AlF(g) → Al(g) + MF(g), where M = Ca, Sr, Ba, were 32.7 ± 0.2, 33.1 ± 0.3, and 23.9 ± 0.2 kcal/mole, respectively. The measured heats of the heterogeneous reactions M(g) + MF_2(s) → 2 MF(g) were 12.07 ± 0.8, 116.0 ± 0.8, and 97.9 ± 0.4 kcal/mole for M = Ca, Sr, and Ba. These heats were used to calculate D^0_{298}(CaF) = 5.44 ± 0.10, D^0_{298}(SrF) = 5.45 ± 0.10, and D^0_{298}(BaF) = 5.80 ± 0.09 ev. These values are in harmony with the values D^0_{298}(BeF) = 6.25 and D^0_{298}(MgF) = 4.55 ev based on thermochemical studies by other workers, but are considerably higher (by 1 to 3 ev) than previously accepted values derived from molecular band spectra. An ionic model, using estimated values of the polarizability $\alpha(Be^+)$ = 0.84, $\alpha(Mg^+)$ = 2.2, $\alpha(Ca^+)$ = 6.0, $\alpha(Sr^+)$ = 8.6, $\alpha(Ba^+)$ = 11.3 A^3, gives values of the dissociation energies which compare very well with those derived from this and other thermochemical data. An average value for the ratio D(MF)/D(MF_2) of 0.46 was computed, which shows that there is not a great difference in the M−F bonds in the mono- and dihalides. (Dissertation Abstr. 23: May 1963)

25270 ALIGNMENT OF TRAPPED H_2^+ MOLECULAR IONS BY SELECTIVE PHOTODISSOCIATION. Keith Bartlett Jefferts. Thesis, Seattle, Univ. of Washington, 1962. 61p.

An observation of alignment of H_2^+ molecular ions contained in a quadrupole rf trap is described. One of the low-field g-factors $|g_\Gamma| \approx 2/5$ was measured; the details of the measurement are included. H_2^+ molecular ions were produced from background H_2 by electron impact and contained in a quadrupole rf trap. Pressures of the order of 10^{-9} mm were necessary in order to provide sufficiently long life-

times of the ions. Alignment in the sample of H_2^+ was produced through the mechanism of selective photodissociation. This was achieved by illuminating the sample of H_2^+ with light from a high pressure mercury arc. The light was linearly polarized parallel to the static magnetic field. For such illumination, the photodissociation cross section for a given ion depends on its magnetic quantum number M_F, or more correctly, upon the magnitude of the magnetic quantum number $|M_F|$. As the photodissociation reaction proceeds, this results in both a non-equilibrium distribution of the remaining H_2^+ among its magnetic substates, and a different net dissociation rate than if the alignment were continuously destroyed. The different dissociation rate is the measurable parameter which serves to identify such Zeeman resonances. Magnetic resonances were observed in magnetic fields of approximately 0.3 gauss and 0.9 gauss with a g-factor $|g_F|$ approximately equal to $\frac{2}{5}$. These resonances are ascribed to $\Delta F = 0$, $\Delta M_F = \pm 1$ transitions in the states for which $K = 2$, $F_2 = \frac{1}{2}$, $F = \frac{5}{2}, \frac{3}{2}$ and $K = 1$, $F_2 = \frac{3}{2}$, $F = \frac{5}{2}$. These states are all expected to have g-factors $|g_F|$ approximately equal to $\frac{2}{5}$ and are all expected to contribute significantly to the observed resonance. The resonance appears as a single line in a field of 0.3 gauss but resolved into several components in a field of 0.9 gauss, indicating the onset of a Back-Goudsmit effect. Extension of the technique to the measurement of the $\Delta F = \pm 1$ hyperfine frequencies appears feasible. (Dissertation Abstr. 23: May 1963)

25271 NUCLEAR MAGNETIC RESONANCE OF FLUID XENON. Earle Raymond Hunt. Thesis, New Brunswick, N. J., Rutgers Univ., 1962. 56p.

Studies of fluid samples of natural xenon were continued using the free precession technique of nuclear magnetic resonance. The Xe^{129} relaxation time in gaseous and liquid xenon was measured using new samples whose impurity content is lower than that used by Streever and Carr. In contrast to the previous results the relaxation rate was proportional to the density of the gas: $1/T_1 = (5.0 \pm .5) \times 10^{-6} \rho$ (ρ in amagats). In the liquid in equilibrium with its vapor $T_1 = 1000$ sec; no temperature dependence was found within the experimental error of 20% for the samples in the range 0 to −72°C. In both the liquid and gas the shift in the resonant field was proportional to the density and the external field: $\Delta H = (4.22 \pm .05) \times 10^{-7} \rho H_0$. The diffusion coefficient also was measured in the dense gas and liquid. Progress was made in the theoretical understanding of the data. Fluctuating magnetic fields exist at the nucleus as a result of the rotational motion of the non-symmetrical electronic charge distribution which occurs when two atoms collide. These charge distortions and their motion can constitute a mechanism for both the resonant shift and the spin relaxation. Using a procedure similar to that developed by Ramsey for diatomic or linear molecules, Torrey obtained a relationship between the relaxation rate and the shift. The relationship agrees well with the experimental results. (Dissertation Abstr. 23: May 1963)

25272 THE FERROELECTRIC-ANTIFERROELECTRIC TRANSITION AND DIELECTRIC PROPERTIES IN THE TERNARY SYSTEM $PbZrO_3-PbHfO_3-PbTiO_3$. Charles Ainsley Hall. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 68p.

Variations in phase behavior between the binary systems $PbZrO_3-PbTiO_3$ and $PbHfO_3-PbTiO_3$ previously were reported. This behavior led to the investigation of the ferroelectric-antiferroelectric transition and dielectric properties in the ternary system $PbZrO_3-PbHfO_3-PbTiO_3$. The investigation included compositions up to 10 mole % $PbTiO_3$ on the $PbHfO_3-PbTiO_3$ binary and the $Pb(Zr_{.5}HF_{.5})O_3-PbTiO_3$ tie line. Similar compositions on the $PbZrO_3-PbTiO_3$ binary were prepared for comparison. Ceramic specimens were prepared using a moderately pure hafnium oxide (98.5% HfO_2). The raw materials were mixed and then calcined for six hours at 850°C to form the desired compositions. Ceramic properties including bulk density, apparent porosity, and weight change after firing are reported for all compositions. Dielectric constant and dissipation factor were measured as a function of temperature and anomalies or peaks in the curve of dielectric constant versus temperature were used as indications of phase transitions. To determine the electrical nature of the phases present, the relationship between applied electric field and dielectric displacement was observed with the aid of a Sawyer-Tower circuit. Pyroelectric discharge measurements were made on selected samples. X-ray investigation was limited to a study of the room temperature phases present. Phase diagrams determined from electrical measurements are presented for the two binaries investigated. An important feature of the diagram for the high hafnate region of the $PbHfO_3-PbTiO_3$ binary was that for a narrow compositional region between $Pb(Hf_{.95}Ti_{.05})O_3$ and $Pb(Hf_{.90}Ti_{.10})O_3$ an antiferroelectric phase exists at a higher temperature than the ferroelectric phase. This was determined from the fact that $Pb(Hf_{.925}Ti_{.075})O_3$ exhibited a polymorphic inversion from a ferroelectric to an antiferroelectric with ascending temperature. This order of phase transition, ferroelectric to antiferroelectric, was contrary to the phase behavior in the $Pb(Zr_{.5}Hf_{.5})O_3-PbTiO_3$ and $PbZrO_3-PbTiO_3$ compositions. In these two cases the transition at the morphotropic phase boundary was antiferroelectric to ferroelectric. Two antiferroelectric phases were shown to exist for compositions near the $PbHfO_3-PbZrO_3$ binary. Photographs of polarization as a function of applied electric field are shown for selected compositions and values of remnant polarization and coercive field tabulated. For a given concentration of $PbTiO_3$, additions of $PbHfO_3$ to $PbZrO_3$ caused an increase in the coercive field and decreased the remnant polarization. (TCO)

25273 THERMODYNAMIC PROPERTIES OF ALUMINUM NEAR ITS SUPERCONDUCTING CRITICAL TEMPERATURE. Don Carlos Hopkins. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 89p.

The specific heat, latent heat, and critical field of a single crystalline sphere of 99.995% pure aluminum were measured simultaneously between 1.06 and 1.19°K. These three quantities are thermodynamically related, but the evidence existing at the inception of this work indicated a discrepancy between the critical field and specific heat much larger than the experimental uncertainty. However, the independently measured thermodynamic properties were found to be much more consistent than previously observed. The specific heat and critical field measurements were found to be consistent with each other within experimental error, but the latent heat was found to deviate by a small but experimentally significant amount from consistency with the other two measured quantities. The detailed shape of the specific heat curve near T_c was also measured in a magnetic field less than 10^{-3} gauss with temperature intervals as fine as 18×10^{-6}°K. Temperature changes as small as 5×10^{-6}°K were detectable with power dissipation of .002 ergs/sec and time constant of 2.5 sec. The transition occurred at 1.180 ± .001°K with a smooth change in specific heat of 2.21 mj/mole°K which was complete in about 2×10^{-3}°K. The width and shape of the transition were compared with a calcula-

tion based on temperature fluctuations. (Dissertation Abstr. 23: May 1963)

25274 DEVELOPMENTS IN APPLIED SPECTROSCOPY. VOLUME 2. Proceedings of the Thirteenth Annual Symposium on Spectroscopy Held in Chicago, Illinois, April 30-May 3, 1962. J. R. Ferraro and J. S. Ziomek, eds. New York, Plenum Press, 1963. 446p. $16.00.

A total of 41 papers are presented on infrared and Raman spectroscopy, nuclear magnetic resonance, ultraviolet spectroscopy, emission spectroscopy, x-ray spectroscopy, and gas chromatography. Separate abstracts were prepared for four of the papers, while two of the remaining papers were previously abstracted in NSA. (D.L.C.)

25275 NANOSECOND TIME RESPONSES OF DIFFERENT INDIUM ANTIMONIDE PHOTODETECTORS. Heinz Fischer and Harold Rose (Air Force Cambridge Research Labs., Bedford, Mass.). p.29-33 of "Developments in Applied Spectroscopy. Vol. 2." New York, Plenum Press, 1963.

Nanosecond time responses of PEM and PC indium antimonide detectors as determined by means of a new light source promise considerable interest for nanosecond infrared spectroscopy—such as flash photolysis, for example. Light output and cell sensitivity are adequate. Until now, this combination of an ultrafast light source and an infrared detector very nearly as fast has not been available. (auth)

25276 THE VIBRATIONAL SPECTRA OF TRANS-$C_2H_2I_2$ AND TRANS-$C_2D_2I_2$. Robert H. Krupp, Edward A. Piotrowski, Forrest F. Cleveland, and Sidney I. Miller (Illinois Inst. of Tech., Chicago). p.52-7 of "Developments in Applied Spectroscopy. Vol. 2." New York, Plenum Press, 1963.

The Raman and infrared spectra of trans-$C_2H_2I_2$ and trans-$C_2D_2I_2$ were measured in CS_2 and CCL_4 solutions at 400 to 4000 cm^{-1}. The results are tabulated along with the vibrational frequency assignments. The fundamentals are compared with these of trans-$C_2H_2F_2$, $C_2H_2Cl_2$, $C_2H_2Br_2$, and their deuterated analogs. (D.L.C.)

25277 RAMAN SPECTRAL DATA, ASSIGNMENTS, POTENTIAL ENERGY CONSTANTS, AND CALCULATED THERMODYNAMIC PROPERTIES FOR CH_2Cl_2, $CHDCl_2$, AND CD_2Cl_2. F. E. Palma and K. Sathianandan (Illinois Inst. of Tech., Chicago). p.58-64 of "Developments in Applied Spectroscopy. Vol. 2." New York, Plenum Press, 1963.

An investigation was conducted on the Raman spectra of the three compounds in order to derive potential energy constants from the spectra. The Raman spectra are tabulated, and the assignments are discussed. (D.L.C.)

25278 ADSORPTION SPECTRA OF URANYL HALIDES. K. V. Narasimham (Andhra Univ., Waltair, India). p.142-59 of "Developments in Applied Spectroscopy. Vol. 2." New York, Plenum Press, 1963.

The absorption spectra of three different uranyl fluorides and uranyl chloride were investigated in powder form at liquid air temperature. For anhydrous fluoride and uranyl fluoride I, the data of bands are reported for the first time; for uranyl fluoride II, 32 additional bands were obtained. The absorption spectra of the anhydrous fluoride and fluoride I were found to consist of four and three systems, respectively. New analyses of bands are proposed for uranyl fluoride II and uranyl chloride on the basis of five and six systems, respectively. The wavenumbers of the 0,0 bands of the various systems obtained for the four compounds are as follows: anhydrous uranyl fluoride, 20,236, 20,386, 21,186, and 21,277 cm^{-1}; uranyl fluoride I, 20,014, 23,160, and 23,429 cm^{-1}; uranyl fluoride II, 20,080, 20,753, 21,217, 22,723, and 23,083 cm^{-1}; uranyl chloride, 20,530, 21,107, 21,162, 21,234, 22,346, and 22,501 cm^{-1}. For uranyl fluoride I and uranyl chloride, the wavenumbers of the fundamentals obtained from the analyses of the absorption spectra were correlated with those obtained in fluorescence, Raman, and infrared spectra by different workers. (auth)

25279 RARE EARTH ARSENIDES. Lothar H. Brixner (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,087,792. Apr. 30, 1963. Filed Mar. 23, 1960.

A process for the production of rare-earth arsenides is patented. Specific arsenides produced are EuAs, GdAs, TbAs, DyAs, HoAs, ErAs, TmAs, and YbAs. Portions of the finely divided rare-earth element are mixed with an equimolar quantity of arsenic, also finely divided. The mixture is compacted and heated in an inert atmosphere to ~350°C, where a violent exothermic reaction is initiated, which produces the desired end product. The product can then be compacted into a desired shape. The arsenides are semiconducting materials, which can be used in thermoelectric applications at high temperatures. (M.P.G.)

25280 A METHOD FOR PRODUCING ZIRCONIUM DIBORIDE. Perry G. Cotter and Ralph A. Potter (to U. S. Dept. of Interior). U. S. Patent 3,088,805. May 7, 1963. Filed Aug. 21, 1959.

A method for making a self-bonding ZrB_2 abrasive and refractory material is patented. A mixture of zirconium silicate (zircon) particles, boron carbide (or boron carbide and boron oxide), and carbon are reacted in a C crucible under vacuum or an inert atmosphere at temperatures from ~1350°C to ~1900°C. The reaction product is removed from the crucible, screened to remove any C present, and placed in a graphite die, where it is subjected to heat and pressure to obtain the desired material. (M.P.G.)

Organic Chemistry

Refer also to abstracts 25995 and 26781.

25281 (EUR-33.e) 1,2,4-TRIPHENYLBENZENE SYNTHESIS, PURIFICATION AND PHYSICAL BEHAVIOR. G. Barbero and F. Geiss (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1962.

1,2,4-triphenylbenzene was synthesized by a previously described method but the same crystal form was not obtained. The processing of the reaction mixture with the aid of a chromatographic column and the checking of the column eluates by means of thin layer chromatography are described. The low-melting form was isolated from a mixture that was obtained by benzene pyrolysis. By seeding and repeated co-melting it was transformed into the higher melting form. There is not much difference between the two crystal forms as far as their infrared spectra are concerned. However, Debye-Scherrer patterns definitely confirmed the existence of two different forms of crystals. (P.C.H.)

25282 (TID-18749) ORGANOMETALLIC COMPOUNDS OF THE ACTINIDES. Quarterly Progress Report, February 15, 1963–May 15, 1963. (Ethyl Corp. Research and Development Dept., Detroit). Contract AT (11-1)-999. 5p.

Two new organometallic compounds of uranium and thorium are synthesized by reaction of the corresponding metal halide with sodium cyclopentadienide and potassium cyclopentadienide, respectively. Characterization of the thorium compound is nearly complete, but not for the ura-

nium derivative. The thorium compound is $Th(C_5H_5)_3Cl$ and the uranium compound is either $U(C_5F_5)_3$ 2THF (THF = tetrahydrofuran) or $U(C_5H_5)_3 \cdot 2C_4H_9O$. The thorium compound is diamagnetic; chemical and physical properties point to π bonded cyclopentadienyl rings. (auth)

25283 THE MECHANISM OF A DIELS-ALDER REACTION. Stanley Seltzer (Brookhaven National Lab., Upton, N. Y.). J. Am. Chem. Soc., 85: 1360-1(May 5, 1963). (BNL-6636)

Nuclear magnetic resonance studies were carried out on the deuterium isotope effect in the decomposition of the Diels-Alder adduct from 2-methylfuran and maleic anhydride. The results indicate that both bonds break simultaneously in the reversion. (D.L.C.)

25284 SYNTHESIS OF DEUTERIUM DERIVATIVES OF L-ASPARTIC ACID. Nobuo Tamiya and Tairo Oshima (Tokyo Medical and Dental Univ.). J. Biochem. (Tokyo), 51: 78-88(Jan. 1962).

All the possible deuterium derivatives of L-aspartic acid were prepared by combining various enzymic and chemical reactions. Deuterium analysis by mass spectrometry showed the syntheses proceeded as expected. A comparison of the infrared absorption spectra of the 16 preparations showed they were all different and not contaminated with each other, suggesting an absolute specificity of the enzyme reactions employed. The infrared spectra showed that preparations with a H atom on the α carbon show 2 absorption peaks around 1340 cm^{-1} that disappear on deuteration. They can easily be assigned to 2 α-CH bending vibrations. The preparations with β-CH_2 or β-CHD groups show an absorption around 1260 cm^{-1}. They can be assigned to β-CH_2 wagging vibration or to β-CH bending vibrations. (TCO)

25285 MOLECULAR ACOUSTICAL STUDIES OF ORGANIC REACTOR COOLANTS. H. U. Woelk. Thesis, Berlin, Technische Universität, 1961. 51p. $2.00.

The properties of organic coolants are discussed. The mean molecular weight of an organic coolant (a mixture of isomeric terphenyls) was determined as a function of temperature and time. The acoustical properties of a larger number of organic compounds which play an important role as reactor coolants or disintegration products are studied. The design of a high temperature ultrasonic interferometer and an electromagnetic densitometer is described. Measurements of the acoustical properties of 29 organic compounds were made with these instruments. The results are compared with calculations using the kinetic theory of Schaafs. (Gmelin Inst.)

Radiation Chemistry and Radiochemistry

Refer also to abstracts 24787, 25020, 25021, 25022, 25031, 25527, 25528, 25531, 26147, 26162, 26212, 26451, 26782, and 26783.

25286 (BNL-6948) THE SYNTHESIS OF XENON COMPOUNDS IN IONIZING RADIATION. D. R. MacKenzie and R. H. Wiswall (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-1)-Gen-16]. 22p.

Xenon and F form compounds when irradiated with γ rays or energetic electrons. At room temperature and above a mixture of XeF_2 and XeF_4 is formed; at a temperature of about −35°C, XeF_2 is the only product. Utilization of absorbed energy is efficient since initial G-values for consumption of Xe are in the range of 5 to 15 atoms per 100 ev absorbed. XeF_4 is relatively stable to γ radiation, with an initial G-value at 45°C of 0.6 to 1.8 depending on the decomposition products. Krypton and F have not been made to react in an electron beam at temperatures around −130°C. (auth)

25287 (TID-18812) PRIMARY CHEMICAL PROCESS IN THE RADIOLYSIS OF LIQUIDS. Annual Progress Report, September 15, 1962 to September 14, 1963. Conrad N. Trumbore (Delaware. Univ., Newark). June 7, 1963. Contract AT(30-1)-2668. 9p.

Investigations were made on the radiation chemistry of cysteine in aqueous solutions, radiolysis and photolysis of cyclopentanone, thermal exchange reactions of ethyl iodide in iodine tracer solutions, oxygen effect in radiolysis of ferrous sulfate solutions, composition of radiolytic hydrogen produced in light and heavy water solutions, and radiolysis of ferrocyanide. Results are reported where possible. (P.C.H.)

25288 DEPENDENCE OF THERMOLUMINESCENCE UPON SAMPLE SURFACE AREA AND ENVIRONMENTAL GAS PRESSURE. J. G. Carter, D. R. Nelson, and L. G. Augenstein (Oak Ridge National Lab., Tenn.). Appl. Phys. Letters, 2: 226-7(June 1, 1963).

Experiments showed that the thermoluminescence from x-ray irradiated biological materials such as the aromatic amino acids and the protein trypsin increased with the experimental gas pressure. Thermoluminescence from NaCl and KCl crystals ranging in size from single crystals to powder fell as the gas pressure on the powders was reduced, but was always much greater for the powders than for the single crystals. (D.C.W.)

25289 THE EFFECT OF ELECTRIC FIELDS, AND A RELATED DEPENDENCE ON DOSE RATE, IN THE γ-RADIOLYSIS OF HYDROCARBON GASES. T. W. Woodward and R. A. Back (National Research Council, Ottawa). Can. J. Chem., 41: 1463-8(June 1963). (NRC-7301). (In English)

The effect of electric fields on the γ radiolysis of ethane, propane, and the butanes was investigated briefly at 800 mm pressure with dose rates between 2×10^{16} and 400×10^{16} ev/cc/sec. Yields of hydrogen were reduced when a saturation field was applied, except with ethane at low dose rate, where a slight increase in hydrogen yield was observed. With propane and n-butane, the yield of hydrogen in the presence of a saturation field was independent of dose rate, while with ethane, it decreased with decreasing dose rate. At the same time, a dose rate dependence was discovered in the simple radiolysis, in the absence of any field, of ethane, propane, and n-butane, a decrease in the yield of hydrogen at low dose rates being observed. An explanation of the observations is suggested in terms of a competition between neutralization of ions in the gas phase and diffusion of ions to the wall. (P.C.H.)

25290 POLYMERIZATION OF VINYL CHLORIDE IN THE GAS PHASE BY X-RAYS. Jan A. Herman and Pierre M. Hupin (Laval Univ., Quebec). Can. J. Chem., 41: 1578-87(June 1963). (In French)

The polymerization of vinyl chloride in the gas phase by x rays gives a solid polymer of 1140 average molecular weight. The G value of monomer disappearance varies from 100 to 400 and depends on pressure and temperature. From the measure of the rate of polymerization it was possible to deduce the activation energy of the chain propagation steps: 2.5 kcal/mole, and that of the hindered termination process: 7.4 kcal/mole. The negative temperature coefficient of the polymerization is explained by the importance of this hindered termination process. (auth)

25291 CATALYTIC PROPERTIES OF ALUMINAS OBTAINED FROM HYDRARGILLITE IRRADIATED WITH γ RAYS OR NEUTRONS. Gisèle Dalmai, Michel Boury, Jean Elston, and Boris Imelik (CNRS, Villeurbanne, Rhone, France; Faculte des Sciences, Paris; and CEA, Saclay, France). Compt. Rend., 256: 3468-70(Apr. 17, 1963). (In French)

The catalytic activity, with respect to the decomposition of formic acid, of an alumina obtained by the calcination of hydrargillite is increased when this trihydrate is irradiated by neutrons or γ rays. The physicochemical properties and the selectivity are equally modified. (tr-auth)

25292 ABSOLUTE STANDARDIZATION WITH A NaI(Tl) CRYSTAL. I. CALIBRATION BY MEANS OF A SINGLE NUCLIDE. G. A. Brinkman, A. H. W. Aten, Jr., and J. Th. Veenboer (Inst. for Nuclear Physics Research, Amsterdam). Intern. J. Appl. Radiation Isotopes, 14: 153-7(Mar. 1963). (In English)

The absolute standardization of radioisotopes, emitting two γ rays in coincidence, is possible by means of a NaI(Tl) crystal spectrometer. For the absolute activity (N) of such a radioisotope, the following relation can be derived: $N = (A_1A_2/A_{12}) + T$. A_1 and A_2 are the areas under the photopeaks of γ_1, and γ_2, respectively, A_{12} is the area under the sum-peak and T the area under the whole spectrum. The method is tested with Co^{60} and Sc^{46}. (auth)

25293 THE RADIATION AND PHOTOCHEMISTRY OF AQUEOUS SOLUTIONS OF BENZENE. Israel Loeff and Gabriel Stein (Hebrew Univ., Jerusalem). J. Chem. Soc., 2623-33(May 1963).

Saturated aqueous solutions of benzene, when irradiated with x rays in the presence of oxygen, yield as major primary products phenol (G 1.8) as well as mucondialdehyde [G 1.5 (acid solutions), 0.8 (neutral solutions)]. Another primary product is probably pyrocatechol [G = 0.3]. It is shown that both phenol and mucondialdehyde may be formed by way of free-radical intermediate. The yields of phenol and of mucondialdehyde depend on the dose rate. A mechanism accounting for the aromatic ring-opening is discussed. The photochemistry of saturated aqueous solutions of benzene was investigated in the presence and absence of oxygen. In the presence of oxygen at neutral pH, the main photochemical product is mucondialdehyde, and phenol is not formed in significant amounts. At acid pH values in the presence of oxygen, mucondialdehyde is not formed and acid-catalyzed addition of water to benzene appears to prevail. With evacuated solutions the latter process appears to predominate at all pH's. (auth)

25294 α-ANNEALING OF NUCLEAR RECOIL ATOMS. P. N. Dimotakis and M. I. Stamouli (Nuclear Research Centre Democritus, Athens). J. Inorg. Nucl. Chem., 25: 473-81(May 1963).

The effect of α-particle bombardment on the retention phenomena in a neutron-irradiated cobalt complex was examined. α-particles were produced in the solid system from the $B^{10}(n,\alpha)Li^7$ reaction, occurring in mixtures of the complex with boric acid or ammonium hydrogen tetraborate. An increase in the retention of Co^{60} in these mixtures was observed, depending on the dose of recoil α-particles and Li^7 atoms (from 10 to 83 Mrads). The kinetics of the isothermal annealing of these mixtures was also examined. (auth)

25295 RESIDUE ADSORPTION. I. SEPARATION OF STRONTIUM-90 AND YTTRIUM-90. H. W. Kirby (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem., 25: 483-99(May 1963).

A new separation technique is presented, based on the tendency of the hydrolyzed species of certain elements to become adsorbed on any available surface. To separate Sr^{90} and Y^{90}, a dilute acid solution of the radioelements is evaporated to dryness, and the residue is covered with dilute ammonium hydroxide. The solution is evaporated to dryness, and the residue is washed with distilled water. Y^{90} remains adsorbed by the surface, while Sr^{90} is separated in the distilled water. The adsorption of Y^{90} is independent of the nature of the surface, being nearly quantitative on Teflon, glass, stainless steel, tantalum, gold, and platinum. The classical (Freundlich) isotherm is followed in the presence of yttrium carrier. The degree of separation (i.e., the fraction of the Sr^{90} remaining with the Y^{90}) is dependent upon the drying temperature and probably upon the nature of the surface. Y^{90} of any desired degree of purity can be prepared with negligible loss by repeated dissolution, hydrolysis, and washing. The method is applicable to the determination of total rare earths in the picogram range. (auth)

25296 RADIOLYTIC PROBLEMS IN WATER REACTORS. R. G. Sowden (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 8: 81-101 (Jan.-Feb. 1963). (In English)

The existing state of knowledge on the radiation chemistry of water in relation to its use in nuclear reactors is reviewed. Factors that control the relative yields of molecules and radicals and those which determine the subsequent reactions of the radicals are described. Water radiolysis in non-boiling heterogeneous reactors, boiling heterogeneous reactors, homogeneous aqueous reactors, and steam-cooled reactors is discussed. (M.C.G.)

25297 LABELING FATTY ACIDS BY EXPOSURE TO TRITIUM GAS. III. METHYL STEAROLATE AND METHYL LINOLENATE. H. J. Dutton, E. P. Jones, V. L. Davison, and R. F. Nystrom (Northern Regional Research Lab., Peoria and Univ. of Illinois, Urbana). J. Org. Chem., 27: 2648-9(July 1962).

The 12,13- and 9,10-double bonds of methyl linoleate were found to add tritium in a ratio of 1.4 to 1, respectively. The acetylenic fatty acid ester, methyl stearolate, on exposure to tritium and on subsequent analysis was shown to yield cis- and trans-9,10-tritiooctadecenoate as the major radiochemical product and to give minor amounts of radioactive methyl stearate (saturation) and stearolate (substitution). Radioactivity observed in the C_9 dibasic and C_9 monobasic acids resulted from substitution by tritium for the carbon-bonded hydrogen at carbon atoms other than numbers 9 and 10. Radioactivity in the C_9 mono- and dibasic acids corresponded to the 3 to 4% tritiated methyl stearolate isolated by liquid-liquid chromatography and gas-liquid chromatography before oxidation; radioactive stearic acid corresponded to the 9% tritiated stearic acid similarly isolated by chromatography of the uncleaved fatty acid esters. The octadecatrienoate ester, methyl linolenate, on tritium exposure and oxidative cleavage yielded some radioactive mono- and dibasic acids. Unexpectedly, a comparatively large amount of activity (20.3%) was associated with the linolenate peak, indicative of considerable reaction by substitution. (TCO)

25298 TRITIUM LABELING, SIMPLE AND SAFE. S. Steven Brodie (Jewish Memorial Hospital, New York). Jewish Mem. Hosp. Bull., 6-7: 33-8(Mar. 1962).

A modified Wilzbach procedure is described, as well as an apparatus for the preparation of uranium tritide from U metal and T gas. U metal turnings (6 to 8 mesh) are allowed to react with H at 150°C, the system is evacuated, and the uranium hydride is heated to 300 to 350°C. The

liberated H is pumped off and the system refilled with T gas, the temperature being kept below 400°C before being reduced to that of room temperature. By subsequent heating of the uranium tritide thus formed, T can be made available for labeling tracer metabolites by the Wilzbach method. A Tesla coil operated at 15000 to 25000 v is used to provide an arc in the reaction chamber where the labeling is usually completed in 5 to 10 min. The unused T and replaced H are resorbed by U metal. Some labeled compounds need further purification, which may be effected by chromatography, ion exchange, electrophoresis, crystallization, or solvent extraction. Compounds successfully prepared by the method are: ACTH, DOCA, hypoxanthine, folic acid, methotrexate, thymine, purines, and amino acids. The yields ranged from 30 μC to 3 mC/mg, depending upon the number of nonlabile H positions that are available. Compounds with sugars attached, such as thymidine, are not amenable to the procedure. Tritiated water, catalysts, and heat are used to prepare the compounds. It was found that water-soluble compounds, tritiated at a double bond, are best preserved by adding Na_2SO_3 or weak $(NH_4)_2S$. For compounds soluble in nonaqueous solvents, some antioxidants used by rubber companies proved valuable. (TCO)

25299 TRITIUM RECOIL ATOMS AND INTRAMOLECULAR ENERGY TRANSFER. V. V. Pozdeev, An. N. Nesmeyanov, and B. G. Dzantiev (Moscow State Univ.). Kinetika i Kataliz, 4: 318-19(Mar.-Apr. 1963). (In Russian)

The process of intramolecular energy transfer was studied on the basis of tritium recoil reactions with alkylbenzenes (ethylbenzene, n-butylbenzene, tri-butylbenzene, and di-butylbenzene). Radiochromatographic analysis was made of LiC specimens irradiated (for 30 min) in a reactor by slow 5×10^{12} neutron/cm^2 sec. The activity of $Li^6(n,\alpha)T$ recoil atoms was compared to the activity of benzene with assigned magnitude of 100. The results are tabulated. (R.V.J.)

25300 RADIATION-INDUCED COPOLYMERIZATION OF ACRYLONITRILE AND STYRENE. Hiroshi Sobue, Yoneho Tabata, and Yoshio Hashizume (Japanese Assn. for Radiation Research on Polymers, Tokyo). Kogyo Kagaku Zasshi, 65: 1883-6(Nov. 1962).

Copolymerization of acrylonitrile and styrene induced by ionizing radiation was investigated in bulk. Variables studied were: the dependence of the copolymerization rate on dose rate, polymerization temperature, and monomer ratio in the monomer mixture; and the composition curves of copolymerization at various temperature. The copolymerization rate was proportional to the square root of dose rate in the molar equivalent mixture of monomers at room temperature. The apparent activation energy of the copolymerization was 6.90 kcal/mole in a molar equivalent mixture of monomer. The copolymerization rate increased with the mole fraction of acrylonitrile in the monomer mixture. It was concluded from the composition curves of polymerization that the copolymerization probably occurs by a radical mechanism in the range from room temperature to −20°C and by both anionic and radical mechanisms at near −78°C. (H.H.D.)

25301 FAST SEPARATION OF RADIONUCLIDES BY THIN-LAYER CHROMATOGRAPHY. A. Breccia and F. Spalletti (Università, Bologna; Università, Padua; and Centro Nazionale di Chimica delle Radiazioni e dei Radioelementi, Bologna). Nature, 198: 756-8(May 25, 1963).

A fast chromatographic method is described for the separation of fission products and radionuclides from their decay products. Results are reported for the separation of Zr^{95} from Nb^{95} and Sr^{90} from Y^{90}. (C.H.)

25302 REMOVAL OF STRONTIUM-90 FROM MILK. Joseph Silverman, Dipen Ghosh, and Ralph L. Belcher (Univ. of Maryland, College Park). Nature, 198: 780 (May 25, 1963).

A practical, efficient, safe, and inexpensive method is described for the removal of Sr^{90} from milk. Milk is contacted with slightly soluble calcium phosphate and then separated from the added salts. About 90% of the Sr in raw milk is removed by the method. (C.H.)

25303 ENERGY DEPOSITION BY FAST NEUTRONS: NO_2 PRODUCTION IN LIQUID AIR. Robert C. Axtmann and John Bridgwater (Princeton Univ., N. J.). Nucl. Sci. Eng., 15: 81-9(Jan. 1963).

Fast neutrons deposit energy in chemical systems by means of elastic scattering, inelastic scattering, and various charged particle reactions. For the particular case of 14.6 Mev neutrons and 1:1 solutions of liquid N_2 and O_2, the proportions by which the three classes of reactions contribute are, respectively, about 1:1:4. The initial linear energy transfer (ILET) in the same system is of the order of 20 ev/Å. Dosimetry in fast neutron radiation chemistry experiments may combine a quantitative consideration of each nuclear reaction with a measurement of the neutron flux. This method of dosimetry was applied to experiments on the production of NO_2 in 1:1 liquid N_2 and O_2 with the result that G_{NO_2}, the number of NO_2 molecules formed per 100 ev deposited in the sample, was found equal to 0.5 ± 0.1. This result is surprisingly close to that observed for irradiations by Co^{60} gamma rays and by electrons whose ILET is three orders of magnitude less than that for 14.6 Mev neutrons. (auth)

25304 RADIATION DAMAGE TO FREON-11, CCl_3F. M. D. Silverman, B. O. Heston, and P. S. Rudolph (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 15: 217-18 (Feb. 1963).

Freon-11 was exposed to 2.6×10^{21} ev/ml of electrons in a Pyrex cell cooled to −70°C. Chlorine and fluorine reacted with the metal turnings immersed in the Freon and with the KOH trap, and traces of SiF_4 were also detected. The yields were found to be G(Cl) = 0.62 and G(F) = 0.16. It is concluded that Freon-11 is not stable in a radiation field and would present corrosion problems. (D.L.C.)

25305 WATER DECOMPOSITION BY FISSION FRAGMENT RECOIL ENERGY IN AN AQUEOUS SLURRY OF URANIUM–THORIUM OXIDES. Lawrence R. Steele (Argonne National Lab., Ill.), Sheffield Gordon, and Charles E. Dryden. Nucl. Sci. Eng., 15: 458-67(Apr. 1963). (TID-16934; UAC-6643)

Measurements of the rate of decomposition of water as a function of particle size and concentration of a slurry of fissionable and fertile fuel were made on 10 cc samples of slurry, kept in suspension by a mechanical stirrer, in a nuclear reactor. By passing nitrogen through the slurry during the irradiation, the radiolytic gases were stripped from the slurry before they could recombine. The average particle size of the solids, which contained 10% natural uranium, was varied from 6 to 50 μ in diameter. Concentrations between 300 and 1000 gm/liter were studied. In order to correlate the experimental results, use was made of calculations of the fraction of fission recoil energy that escapes to the fluid in a slurry reactor. The results indicate that the value of $G(H_2)_f$, the number of hydrogen molecules measured for every 100 ev of fission recoil energy absorbed by the water is about 2.1. This is also the value for $G(-H_2O)_f$, the number of molecules of water decomposed by every 100 ev of fission recoil energy under steady-state conditions in a slurry reactor. (auth)

25306 CHEMICAL EFFECTS OF NEUTRON CAPTURE. I. INFLUENCE OF THE AMMONIUM GROUP ON THE THERMAL TREATMENT OF NEUTRON-IRRADIATED AMMONIUM SULFATE. Nikola Getoff and Masaru Nishikawa. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 9, 121-30(June 22, 1961). (In German)

Owing to the nuclear recoil in the irradiation of ammonium sulfate with thermal neutrons about 40% of the active sulfur formed was present as sulfite and could be separated from the target material and obtained in carrier-free form. It was ascertained that the thermal annealing of the recoil fragments below 150°C is a first-order reaction. The ammonium groups influence the course of the annealing processes at temperatures above 150°C at the same time as the annealing of the recoil fragments on opposite reduction process occurs, which also is a first-order type reaction. (tr-auth)

25307 TRIPLET EXCITONS AND DELAYED FLUORESCENCE IN ANTHRACENE CRYSTALS. R. G. Kepler, J. C. Caris, P. Avakian, and E. Abramson (E. I. du Pont de Nemours and Co., Wilmington, Del.). Phys. Rev. Letters, 10: 400-2(May 1, 1963).

Delayed fluorescence was detected in laser-induced fluorescence in anthracene single crystals after the laser pulse ended. The rate of decay of this fluorescence and other experimental observations was explained by assuming that the singlet state giving rise to the fluorescence is produced by a bimolecular annihilation of triplet excitons generated directly by the laser light. The lifetime and the bimolecular interaction rate constant of the triplet excitons were found to be 10 msec and 10^{-11} cm^3 sec^{-1}, respectively. (C.E.S.)

25308 PHOSPHORESCENCE IN ALKALI HALIDES CONTAINING LATTICE DEFECTS. Herbert N. Hersh and Wayne B. Hadley (Zenith Radio Corp., Chicago). Phys. Rev. Letters, 10: 437-8(May 15, 1963).

In the study of phosphorescence in Tl-activated KI and KBr and undoped KI, KBr, and KCl effects commonly attributed to internal metastable states of Tl were observed in specimens containing essentially no Tl at all. The results seem to indicate that the traps that play a major role in energy storage and infrared stimulability in impurity-activated alkali-halide phosphors are characteristic of the undoped host crystal. The internal metastable states of the impurity are not important and the structural defects of the host crystal play a role in phosphorescence that must be taken into account in any valid theory. (C.E.S.)

25309 A MOLECULAR PROCESS IN THE RADIATION-INDUCED OXIDATION OF HYDROCARBONS. G. Dobson and G. Hughes (Univ. of Liverpool). Proc. Chem. Soc., 109 (Apr. 1963).

The effects of added scavenger (triphenylenemethane and iodine) on the gamma radiolysis of oxygenated cyclohexane was studied. The scavenger reduced the yield of cyclohexanone from ~2.0 to a limiting value of 0.46 at the highest scavenger concentrations. The results indicate that, besides the proposed mechanism cyclo-$C_6H_{11}\cdot + O_2 \rightarrow$ cyclo-$C_6H_{11}O_2\cdot$ and 2 cyclo-$C_6H_{11}O_2\cdot \rightarrow$ cyclo-$C_6H_{11}OH$ + cyclo-$C_6H_{10}O + O_2$, there is an additional reaction cyclo-$C_6H_{12}\cdot + O_2 \rightarrow$ cyclo-$C_6H_{10}O + H_2O$. This reaction is supported by the fact that the yield of cyclohexanol is always less than that of cyclohexanone by an amount equal to the limiting value of G(cyclohexanone). (D.L.C.)

25310 THE FLUORESCENT RESPONSE OF NaI(Tl) AND CsI(Tl) TO X RAYS AND γ RAYS. A. J. L. Collinson and R. Hill (Borough Polytechnic, London). Proc. Phys. Soc. (London), 81: 883-92(May 1, 1963).

Detailed and careful measurements were made of the light output L_γ from NaI(Tl) and CsI(Tl) for energies E_γ from 6 to 200 kev, employing filtered characteristic x-rays and γ-rays from radioactive sources; an accuracy of 0.3% for L_γ/E_γ is claimed. The measurements were extended, in less detail, to 2.6 Mev. The scintillation efficiency for single electrons, in the energy range 1 to 100 kev, calculated from the observed values of L_γ/E_γ, was found to be a maximum at 15 kev and at lower energies shows a marked falling off. The results for single electrons are in good agreement with the diffusion theory of Meyer and Murray. (auth)

25311 A REDETERMINATION OF THE SALICYLIC ACID YIELD IN THE AQUEOUS CALCIUM BENZOATE DOSIMETER. W. A. Armstrong, R. A. Facey, D. W. Grant, and W. G. Humphreys (Defence Research Board, Ottawa). Radiation Res., 19: 120-8(May 1963).

G(salicylic acid) or G(Sal) has been determined for 10^{-3} M and 10^{-4} M aqueous calcium benzoate solutions irradiated with Co^{60} γ-rays, 250-Kvcp x rays, 100-Kvcp x rays, and 50-Kvcp x rays. The G(Sal) values for Co^{60} γ-rays of 0.65_5 (10^{-3} M) and 0.59_5 (10^{-4} M) are about 6% lower than previously determined values. Possible sources of error in the measurements have been examined and discussed. For the measurement of low doses (16 rads), the use of chromic acid for cleaning irradiation vessels has been shown to yield irreproducible results. (auth)

25312 EFFECTS OF COMPLEXION ON CRYSTALLIZATION COEFFICIENT. V. I. Grebenshchikova and V. N. Bobrova. Radiokhimiya, 5: 3-8(1963). (In Russian)

Coefficients of Pu(IV) crystallization with K_2SO_4 in 0.5 to 2N HNO_3 solutions were analyzed. It was found that with HNO_3 concentration from 0.5 to 1N the magnitude of the coefficient drops from 30 ± 2 to 4 ± 0.5 (corresponding to K_2SO_4 concentration change from 0.8 to 1.2M). After that it remains constant up to 2N HNO_3 (and 1.8M K_2SO_4) concentration. (R.V.J.)

25313 ON THE PRECIPITATION OF PLUTONIUM WITH POTASSIUM SULFATE. V. I. Grebenschikova and V. N. Bobrova. Radiokhimiya, 5: 9-11(1963). (In Russian)

Solubility of binary $K_4Pu(SO_4)_4$ in saturated potassium sulfate solution 1, 1.5, and 2N HNO_3 was determined. It is shown that the magnitude of Pu(IV) crystallization with K_2SO_4 is related directly to the solubility of $K_4Pu(SO_4)_4$ adsorbed from plutonium solution on the potassium sulfate surface. (R.V.J.)

25314 ADSORPTION OF Pu(VI) ON POLISHED PLATINUM. A. G. Samartseva. Radiokhimiya, 5: 28-32 (1963). (In Russian)

Adsorption of Pu(VI) on non-annealed polished platinum in weak acid or alkali solutions with pH = 7 is quite negligible (1 to 2%). At pH > 7 the adsorption is more pronounced and at pH = 8 it reaches a maximum that drops down to zero at pH ≃ 11. The maximum Pu(VI) adsorption is found to be ~ 30% of the initial content in the solution. (R.V.J.)

25315 SORPTION OF MICRO-QUANTITIES OF STRONTIUM AND CESIUM BY VERMICULITE. V. M. Nikolaev, V. F. Bagretsov, and V. M. Lebedev. Radiokhimiya, 5: 32-7(1963). (In Russian)

Sorption of microquantities of radioactive Cs and Sr on vermiculite from alkali earth chlorides, magnesium and sodium was accomplished by ion exchange and complied with the law of mass action. Vermiculite exchange volume did not vary at pH 3 to 11. Ion exchange constants for vermiculite and sulfo cation KU-2 were found. (R.V.J.)

25316 EXTRACTION METHOD FOR SEPARATING CALCIUM-45 IN CARRIER-FREE FORM FROM SCANDIUM IRRADIATED BY FAST NEUTRONS. V. I. Levin, I. V. Meshcherova, A. B. Marygina, and O. E. Sarvetnikov. Radiokhimiya, 5: 37-41(1963). (In Russian)

Solvent extraction of Sc and Ca from hydrochloric acid by tributylphosphate was studied, and optimum conditions for Sc and Ca separation were determined. A method was developed for separation of carrier-free Ca^{45} from neutron-irradiated scandium with a purification factor of 10^7. The effective cross section of nuclear reaction $Sc^{45}(n,p)Ca^{45}$ is ~18 m barns. (R.V.J.)

25317 EXTRACTION OF INDICATIVE CONCENTRATIONS OF HYDROFLUORIC ACID BY TRIBUTYLPHOSPHATE. SEPARATION OF CARRIER FREE F^{18} FROM NEUTRON IRRADIATED LITHIUM SALTS. V. I. Levin and L. S. Kozyreva. Radiokhimiya, 5: 41-9(1963). (In Russian)

Solvent extraction of carrier-free F^{18} from neutron-irradiated lithium by tributylphosphate was investigated. Maximum distribution coefficients were exhibited in carrier free HF^{18} distribution between tributylphosphate and HCl, HNO_3, H_2SO_4 solutions and LiCl + HCl solutions. Distribution of HF^{18} between TBP and 1N HCl with constant macrocomposition and with variable HF concentration from 10^{-6} to 10^{-2} N was investigated. The relatively constant distribution coefficient indicates the absence of HF polymerization in organic phase. Distribution of HF^{18} between the TBP in CCl_4 and 1N hydrochloric acid solutions was studied. It was shown that carrier-free HF^{18} extraction appears as HF · TBP complex. (R.V.J.)

25318 ON THE REACTION OF COMPONENTS IN $MeNO_3-UO_2(NO_3)_2-H_2O$ TYPE SYSTEMS. M. A. Yakimov, N. F. Nosova, A. Ya. Degtyarev, and Ch'ien-Ch'i Yü. Radiokhimiya, 5: 73-80(1963). (In Russian)

Solubility in ternary systems $TlNO_3-UO_2(NO_3)_2-H_2O$ and $CsNO_3-UO_2(NO_3)_2-H_2O$ at 0 to 25°C was studied by the isothermal method. The first system did not form solid phase compounds; the second system formed two compounds $Cs_2UO_2(NO_3)_4$ and $CsUO_2(NO_3)_3$ at 25° and $Cs_2UO_2(NO_3)_4$ at 0°. Dynamic method studies of water vapor pressure over the systems at 25° showed that water activity in the ternary systems at certain concentrations does not exceed the water activity in binary uranyl nitrate-water system (at identical uranyl nitrate concentrations) confirming the observed complex formation in the solution. The mechanism of complex formation was analyzed and expanded for alkali metal–metal salt-complexing agent–water systems. (R.V.J.)

25319 INTERSOLUBILITY IN URANYL PERCHLORATE-WATER-DIETHYL ETHER AND URANYL PERCHLORATE-WATER-DI-n-BUTYL ETHER AT 25°. V. M. Vdovenko, L. G. Mashirov, V. K. Blokhina, I. G. Suglobova, and D. N. Suglobov. Radiokhimiya, 5: 80-9(1963). (In Russian)

Anhydrous uranyl perchlorates and its hydrates ($UO_2(ClO_4)_2 \cdot 7H_2O$($T_{melt}$ = 60°), $UO_2(ClO_4)_2 \cdot 5H_2O$($T_{melt}$ = 112°), and $UO_2(ClO_4)_2 \cdot 3H_2O$($T_{melt}$ = 148°) were prepared. The $UO_2(ClO_4)_2$ solubility in water is 73.3% at 25°C. The solubility of uranyl perchlorate–water–diethyl ether and uranyl perchlorate–water-di-n-butyl ether at 25° was studied and the critical point was found at 25% $UO_2(ClO_4)_2$ and 5% H_2O. A series of equilibrate phases of uranyl chloride-water systems with ethyl ether and dibutyl ether were identified. (R.V.J.)

25320 PRECIPITATION OF AMMONIUM URANYL DISULFATE FROM NITRATE SOLUTIONS. I. A. Kuzin, I. A. Galitskaya, and V. P. Taushkanov. Radiokhimiya, 5: 89-93(1963). (In Russian)

Effects of concentration of ammonium nitrates on $(NH_4)_2[UO_2(SO_4)_2] \cdot 2H_2O$ precipitation from nitrate solutions were determined. Almost complete precipitation from 8M ammonium nitrate solutions in presence of ammonium sulfates was reached at equilibrium sulfate ion concentrations of 0.07 to 0.28M. At higher sulfate ion concentrations precipitation of $(NH_4)_2[UO_2(SO_4)_2] \cdot 2H_2O$ is more efficient in acidified solutions. The higher solubility of ammonium uranyl di-sulfates in presence of ammonium sulfate at sulfate ion concentration above 0.142M and pH = 3.0 to 3.5 is caused by the formation of $[UO_2(SO_4)_3]^{4-}$ complex ions. The equilibrium constant of $(NH_4)_2[UO_2(SO_4)_2] + SO_4^{2-} \rightleftharpoons 2NH_4^+ + [UO_2(SO_4)_3]^{4-}$ reaction in 8M ammonium nitrate solutions is 0.108 ± 0.002. (R.V.J.)

25321 ORGANIC CO-PRECIPITATORS. XVIII. CO-PRECIPITATION OF URANIUM AS OXYQUINOLINATE WITH INDIFFERENT CO-PRECIPITATORS. V. I. Kuznetsov and V. V. Gorshkov. Radiokhimiya, 5: 93-7(1963). (In Russian)

Concentration and separation of small quantities of uranium in uranyl 8-oxyquinolinate form was achieved using phenolphthalein, β-naphthol, and 2,4-dinitroaniline. Quantitative amounts of uranium were precipitated from uranium dilute solutions $1:2 \times 10^6$ by introducing into 200 ml of solution 3 ml 10% phenolphthalein alcohol solution, or 4 ml 10% 2,4-dinitroaniline acetone solution, or 2 ml 20% β-naphthol alcohol solution. Indifferent co-precipitators do not affect selective separation of uranium. (R.V.J.)

25322 STRUCTURE OF TRIHYDRATE URANYL NITRATE. V. M. Vdovenko, E. V. Stroganov, and A. P. Sokolov. Radiokhimiya, 5: 97-103(1963). (In Russian)

An analysis was made by $UO_2(NO_3)_2 \cdot 3H_2O$ crystals, and the complete structure was developed on the basis of Patterson projections and electron density cross sections. It was found that trihydrate uranyl crystal structure is similar to the dihydrate complexes with added water molecules. Similar to other uranyl compounds a six-term particle coordination was found around UO_2^{2+} ion. The x-ray data on intradisposition of particles in $UO_2(NO_3)_2 \cdot 3H_2O$ are in agreement with published data derived by infrared spectra. (R.V.J.)

25323 INVESTIGATION OF PROCESSES AND PRODUCTS OF HIGH-MOLECULAR COMPOUND REACTIONS WITH INORGANIC SALTS. II. FORMATION OF POLY(α-METHYL) ACROLEIN COMPLEXES WITH URANYL NITRATE. I. V. Andreeva, P. F. Andreev, and E. M. Rogozina. Radiokhimiya, 5: 103-6(1963). (In Russian)

Effects of replacing radicals in the acrolein molecule α-position on polymer ability to form uranyl nitrate complex compounds were investigated. It was shown that the poly(α-methyl) acrolein specimens prepared by redox initiators are capable of complexing with uranyl nitrates, while specimens prepared by butyllithium and metallic sodium polymerization are not capable of complexing, neither are the specimens of poly(α-ethyl) and poly(α-propyl)acrolein in presence of metallic sodium. (R.V.J.)

25324 SEPARATION OF CARRIER FREE Y^{90} FROM $Sr^{90} + Y^{90}$ MIXTURE BY DIARYLPHOSPHORIC ACIDS. S. A. Potapova. Radiokhimiya, 5: 110-14(1963). (In Russian)

Extraction of carrier-free Y^{91} by diarylphosphates (diphenylphosphate β-dinaphthylphosphate, dibenzylphosphate in organic solvents $CHCl_3$, CCl_4, C_6H_6, and dicresylphosphate in C_6H_6 and CCl_4 was investigated as a function

of acidity and concentration of the extracting agent. Under certain conditions Y^{91} extracts by weak (0.005M) diarylphosphate solutions. A method was developed for separating radiochemically pure carrier-free Y^{91} from $Sr^{90} + Y^{90}$ mixture in 0.1N HNO_3 by 0.01M dicresylphosphate (or 0.005M dinaphthylphosphate)-benzene. (R.V.J.)

25325 RADIOCHEMICAL STUDIES OF SILVER HALIDE SOLUBILITY AND THEIR ANALOGY TO MONOVALENT THALLIUM HALIDE. V. E. Mironov. Radiokhimiya, 5: 118-25(1963). (In Russian)

Solubility of silver bromide was studied in 1×10^{-6} to 4.0M sodium bromide solution and in 1.0 to 4.0M lithium and potassium solution, and silver iodides in 1×10^{-4} to 2.5M sodium iodide and 1.0 to 2.5M lithium and potassium iodides. It was found that the influence of alkali metal cations on silver bromide and iodide solubility is within the frame influence of direct cation series. The behavior of silver halide is quite similar to the behavior of monovalent thallium solutions containing similar anions, however, silver halides have a lower solubility and a greater tendency to complexing. (R.V.J.)

25326 RECOIL EFFECT OF Co^{60} FOLLOWING (γ,n) REACTION IN COMPLEX COBALT COMPOUNDS. Amar Nat and A. N. Nesmeyanov. Radiokhimiya, 5: 125-34 (1963). (In Russian)

Recoil labeling of annealed cobalt(III) chelates by Co^{59} was studied following $Co^{59}(\gamma,n)Co^{58}$ reaction at 10^4 to 10^5 ev. The effects of thermal treatment and x irradiation on the yield product were analyzed. A stabilization model is suggested for Co^{60} recoil atoms produced by cobalt chelate irradiation by high-energy protons. (R.V.J.)

25327 HYDROLYSIS OF U(IV) ION. V. M. Vdovenko, G. A. Romanov, and V. A. Shcherbakov. Radiokhimiya, 5: 137-8(1963). (In Russian)

It was postulated that the effective magnetic moment increases during U(IV) complexing with fluorine ions and in U(IV) hydrolysis. The proton resonance method was used in experiments verifying the hypothesis. The spin-lattice relaxation time T, of protons in U(IV) 0.03M aqueous solution was studied as a function of the pH. The results confirmed that the effective moment (μ_N) grows with an increasing pH. The calculated magnitude of μ_N at a maximum point (pH = 1.7) is $(0.25 \pm 0.004)\beta$ Bohr magneton. The obtained data coincide with μ_N (0.25 β) for UF^{3+} complex and indicate that at a given pH the U(IV) ions are in the UOH^{3+} ground state. The stability constant for UOH^{3+} is $K = (3_3 \pm 0.3) \times 10^{-13}$ in good agreement with published data. (R.V.J.)

25328 INVESTIGATION OF URANYL CHLORIDE SOLVATION BY TRI-N.-BUTYL PHOSPHATE MOLECULES. V. M. Vdovenko, A. A. Lipkovskii, and S. A. Nikitina. Radiokhimiya, 5: 139-41(1963). (In Russian)

Absorption spectra of prepared $UO_2Cl_2 \cdot 2TBP$ in CCl_4 and in 100% TBP show a considerable difference that is explained by disturbing effects of TBP bonded with uranyl ion to the uranium electron shell. The variations are characteristic for $\lambda = 464$ mμ and $\lambda = 478$ mμ indicating a variable TBP molecule coordination in relation to UO_2Cl_2. The examined system forms $UO_2Cl_2 \cdot 3TBP$ solvate without forming a maximum $UO_2Cl_2 \cdot 4TBP$ solvate. Equilibrium constant of solvate formation in CCl_4 is equal to 3.1 ± 0.2. Thus, the UO_2Cl_2-TBP forms two solvates: $UO_2Cl_2 \cdot 2TBP$ and $UO_2Cl_2 \cdot 3TBP$. A shift of valence oscillations related to uranium P-O-group at 32 cm^{-1} to the side of large wave number reflects the weakening of TBP-uranium bond taking place in $UO_2Cl_2 \cdot 3TBP$ formation. (R.V.J.)

25329 OXIDATION OF PLUTONIUM DIOXIDE BY ATMOSPHERIC OXYGEN. E. E. Zastenker, O. L. Bedina, V. D. Nikol'skii, and M. E. Pozharskaya. Radiokhimiya, 5: 141(1963). (In Russian)

Spectrophotometric and chemical analyses of plutonium dioxide melted with potassium and sodium alkali at 550 to 600°C showed that atmospheric oxygen oxidized $Pu(IV)O_2$ to a higher oxide ($Pu(VI)O_3$) which reacted with alkali forming alkali metal plutonates. (R.V.J.)

25330 PREPARATION OF CARRIER FREE $Ac^{228}(MsTh_2)$ AND $Ra^{228}(MsTh_1)$ BY ION EXCHANGE METHOD. E. Bryukher. Radiokhimiya, 5: 142-3(1963). (In Russian)

A small dimension column was used to reduce the elutriation time in ion exchange separation of $MsTh_2$ (T = 6.13 hours) from $MsTh_1$ (T = 6.7 years). The faster method required the use of practically carrier-free $MsTh_1$. Preparation methods for carrier-free $MsTh_1$ and preparation of radiochemically pure $MsTh_2$ are described. (R.V.J.)

25331 GAMMA IRRADIATION OF POLYPEPTIDES: TRANSFORMATION OF AMINO ACIDS. Felix Friedberg and George A. Hayden (Howard Univ., Washington, D. C.). Science, 140: 825-6(May 17, 1963).

The formation of aspartic acid from glutamic acid, aspartic and glutamic acids from proline, α-aminobutyric acid from methionine, aspartic acid from histidine, dihydroxyphenylalanine from tyrosine, tyrosine and dihydroxyphenylalanine from phenylalanine, alanine from cysteine and glycine from alanine was observed when aqueous solutions of the amino acids in the form of peptides or polyamino acids were irradiated. When poly-L-glutamic acid or poly-L-proline was irradiated in the presence of C^{14}-labeled $NaHCO_3$, the radioactive C was fixed by the aspartic and the glutamic acid. (auth)

25332 RADIOLYSIS OF WATER. Tor Brustad (Norsk Hydros Institutt for Kreftforskning, Oslo). Tidsskr Kjemi, Bergvesen Met., 23: 27-32(Feb. 1963). (In Norwegian)

Developments in the field of radiolysis of water are reviewed, with emphasis placed on the main reactions taking place as a function of the time elapsed after the passage of the ionizing particle. The discussion is divided into three major stages: a) the physical stage, b) the physical-chemical stage, and c) the chemical stage. The diffusion of radicals out of the track of the ionizing particle in competition with various radical combination reactions are discussed in relation to: a) the ionization density, and b) the pH of the water. (auth)

25333 EFFECTS OF ELECTRON BOMBARDMENT UPON BROMIDES OF CADMIUM AND SILVER. Sho Suzuki. Tokyo Kogyo Shikensho Hokoku, 58: 147-9(Mar. 1963). (In Japanese)

Some interesting effects of electron bombardment upon certain inorganic substances were reported by de Souza Santos. Similar phenomena with silver bromide and cadmium bromide under the electron microscope were also observed, although the type of reaction is not the same as that in de Souza Santos's experiments. Electron bombardment of silver bromide causes local reduction to metallic silver and the reduced silver tends to gather locally. In addition, cadmium bromide is photosensitive. Electron bombardment reduced it to metallic cadmium; the reduced metal consists of very minute crystals and keeps closely to the original form of the cadmium bromide. Silver bromide crystallizes in the rock-salt structure, whereas cadmium bromide possesses a hexagonal layer structure which is anisotropic. A figure shows the reductive process due to electron bombardment in the (001) plane of cadmium bro-

mide, where the formation of triangular and hexagonal holes occurs. These suggest the existence of an effect of crystal structure on the morphological changes produced by electron bombardment. The anisotropy of the crystal structure of cadmium bromide apparently controls the mobility of the reduced metal, so that the initial structure persists even after reduction of the original salt. (auth)

25334 PHYSICAL PROCESSES INDUCED BY IONIZING RADIATION IN ALKALI HALIDE CRYSTALS. II. IONIC-ELECTRONIC PHENOMENA IN CREATION AND DESTRUCTION OF COLOR CENTERS IN NaCl SINGLE CRYSTALS. M. A. Elango. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 21, 215-46(1962). (In Russian)

An investigation was carried out on the x ray and uv-induced creation of the color centers, bleaching action of x rays, and thermal destruction of the color centers in NaCl single crystals. It was shown that the velocity of the creation of F- and V-centers depends on the degree of plastic deformation and on previous irradiation. The number of uv-created F-centers passes through a maximum value that is proportional to the number of F-centers created during previous irradiation. Bleaching action of x rays and excitons on the 390-, R-, M-, and N-bands in natural NaCl crystals previously x irradiated and partially bleached in F-band was detected. During the heating of the x-irradiated natural crystals a complicated reciprocal transformation of color centers takes place as a result of ionic processes. (auth)

25335 CHEMICAL EFFECTS OF THE Br^{80m} NUCLEAR ISOMER TRANSITION IN CRYSTALLINE Co, Rh, AND Ir PENTAMMINEBROMO-COMPLEX SALTS. G. B. Schmidt and W. Herr (Universitat, Cologne and Max-Planck-Institut für Chemie, Mainz). Z. Naturforsch., 18a: 505-9(Apr. 1963). (In German)

The percentage of separable Br^{80g-}-ions, following the $Br^{80m} \rightarrow Br^{80g}$ isomeric transition, was determined in labeled pentamminebromo-complexes of Co, Rh, and Ir at various temperatures. In $[Me(NH_3)_5Br](NO_3)_2$ crystals the Br^{80g-}-yields were constant (90, 80, and 77% resp.) over a certain range of temperature, but above 50°, 75°, and 110°C for the Co, Rh, and Ir-complex, respectively, the Br^{80g-}-yields decreased linearly with temperature. The annealing of the metastable fragments was rapid and reached characteristic equilibrium values. The kinetics of this fast reaction was studied and an activation energy of 6.7 kcal/mol was calculated for $[Rh(NH_3)_5Br](NO_3)_2$. In contrast to the bromonitrates, the Br^{80g-}-yields increased with temperature in the Rh and Ir pentamminebromo-halogenid complexes and reached limiting values of ~66% at 210 to 250°C. In this case the excitation energy of the isomeric transition seemed to effect activated exchange reactions between complex bound bromide and anionic bromide or chloride. In the Co, Rh, and Ir-pentamminebromocomplexes investigated, the Br^{80g-}-yield was strongly influenced by the chemical nature of the anion and/or the physical properties of the crystals. Twelve different $[Ir(NH_3)_5Br]X_2$ complexes yielded values of Br^{80g-} between 77% (X = NO_3^- and 41% ($X_2 = C_2O_4^{2-}$) at room temperature. Anions with oxidizing properties showed higher values than those with reducing properties. The latter may favor intermolecular charge neutralization. In an inversion of the above experiments, it was found that in anionic Br^{80m}-labeled Rh-hexamminebromide and also in different Rh and Ir pentammine acido bromides, 9 to 18% of the Br^{80g} daughter atoms were complex bound. These yields were independent of temperature, indicating that substitution reactions of ligand groups occur only by "hot atom" processes. The results were compared with those of the (n,γ) nuclear reaction. (auth)

25336 STABILIZATION OF OXIDIZING COMPONENT IN WATER RADIOLYSIS BY ANIONS. V. A. Sharpatyi and K. G. Yanova (Karpov Inst. of Physics and Chemistry, USSR). Zh. Fiz. Khim., 37: 948-9(Apr. 1963). (In Russian)

The hypothesis on stabilization of oxidizing component in water radiolysis by anions was confirmed by an investigation of the atomic and molecular concentration of hydrogen in frozen acid solutions and in sodium nitrates. A diagram is given of the molecular hydrogen yield as a function of anion concentration. Anion stabilization of the oxidizing radiolysis component was studied by the electron paramagnetic resonance method. It was found that an absorption line (g-factor of 2.015 line) related to the OH radical appeared during radiolysis of aqueous neutral nitrate solutions at g = 2.0036. Further studies using sulfuric (1:5), perchloric (1:7), and phosphoric (86%) acids irradiated at various temperatures and using the acids in presence of glycerine indicated that singlet absorption lines with 2.0103 and 2.0084 g-factor, appear in solutions containing SO_4^{2-} and ClO_4 ions near free electron g factors. In irradiation of the acid solutions in presence of glycerine (0.1M) and OH radical acceptor, as in the case of sodium nitrate solution, the described absorption lines were not found within the range of resolved spectrum lines. (R.V.J.)

25337 PRODUCTION OF NITRIC OXIDES AND RADIOCARBON IN IRRADIATED NITROGEN–OXYGEN SYSTEM. M. T. Dmitriev. Zh. Prikl. Khim., 36: 512-22(Mar. 1963). (In Russian)

Formation of nitric oxide and radioactive carbon in the nitrogen-oxygen system irradiated in a reactor by a flux of 10^{12} to 10^{13} neutron/cm^2 sec was investigated. It was shown that the effect on N–O is identical to that of γ radiation and electrons. Maximum reaction rate in a reactor corresponds to the N to O ratio which is about 3:2 while in other emissions it is 1:1. Reactor energy yield for the air at 1 atm and 30°C is 1.55, at 0.135 atm, 0.6, and at 3.3 atm, 1.2 N_2O molecules per 100 ev. The relative yield of radiocarbon is a function of the mixture composition, neutron flux, pressure, temperature and radiation intensity. At 1 atm and 20°C the ratio for the air is $[C^{14}] : [NO_2] = 2.1 \times 10^{-3}$%. Relations were developed for neutron flux, irradiation intensity, production rate of NO_2, and relative yield of radiocarbon. (R.V.J.)

25338 RADIATION CHEMISTRY STUDIES OF WATER AS RELATED TO THE INITIAL LINEAR ENERGY TRANSFER OF 11-23 Mev PROTONS. Gerald Lawrence Kochanny, Jr. Thesis, East Lansing, Mich., Michigan State Univ., 1962. 85p.

The effect of initial linear energy transfer, $(dE/dx)_i$, or LET_i, in the radiation chemistry of water was studied in the LET_i region from 0.2 to 0.4 ev/Å. Ferrous sulfate, ceric sulfate, and ceric + thallous sulfate dosimeters were irradiated with protons of specific energy in the range 11 to 23 Mev. Representative G values from the yields were obtained for various proton energies. From these results, G values for H, OH, H_2, H_2O_2 as well as G_{-H_2O} were calculated. The work entailed accurate proton beam current and energy measurements for which methods had to be devised. The integrated area under the elastic peak of the energy spectrum of protons scattered by a very thin nickel foil, as recorded by a scintillation counter, was related to the proton beam current absorbed by the sample. Proton beam energies were determined by evaluating the mean range of protons in aluminum. Protons were degraded to approximately 6 Mev. The exact range was determined

from the amount of ferrous ion oxidation effected in a ferrous sulfate dosimeter and the amount of absorber used to degrade the proton beam energy. (Dissertation Abstr.)

25339 CATALYTIC ACTIVITY AND NUCLEAR RADIATION. J. Turkevich, T. Ikawa, F. Nozaki, and D. Stamires (Princeton Univ., N. J.). Contract AT(30-1)-937. 26p. (CN-14/18; TID-18765)

To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, Salzburg, Austria, May 27–31, 1963.

The effects of gamma radiation on the catalytic activity of alumina–silica gel and decationated molecular sieves of the Linde Y type were studied. A graded set of alumina–silica coprecipitated gel catalysts was made with the atomic ratio of alumina–silica having ten different equally spaced values. Another set of catalysts was made by partially replacing the sodium of a Linde molecular Y sieve $Na_{56}(AlO_2)_{56}(SiO_2)_{136}$ by ammonium ion and then decomposing it to drive both the ammonia and the water away to produce a decationated position in the sieve. A graded set of such catalysts was prepared containing varying amounts of these decationated sites from 0 to 100% of the original sodium content. These two sets of catalysts were characterized for catalytic activity before and after gamma radiation by studying the kinetics of cumene decomposition into benzene and propylene, the double bond isomerization of butene-1 to butene-2 and the hydrogen deuterium exchange reaction. The number of active sites was determined by progressive poisoning using quinoline and the activity per site was thus characterized. The materials were also studied by measuring the electron spin resonance of adsorbed electron transfer agents such as triphenylamine, perylene, and symmetrical diphenyl ethylene. The ability to electron transfer was found to be parallel to catalytic activity. Proton resonance of adsorbed water was used to characterize the nature of the catalytic site. (auth)

25340 EFFECTS OF INCORPORATED RADIOACTIVITY AND EXTERNAL RADIATION ON HETEROGENEOUS CATALYSIS. N. A. Krohn and R. G. Wymer (Oak Ridge National Lab., Tenn. and Tennessee. Univ., Knoxville). IAEA Preprint No. CN-14/17. 22p. (TID-18758)

To be published in IAEA Proceedings of the Conference on the Application of Large Radiation Sources In Industry, held in Salzburg, Austria, May 27–31, 1963.

The vapor-phase dehydration of cyclohexanol on magnesium sulfate and magnesium sulfate–sodium sulfate catalysts and the dehydrogenation of methylcyclohexane to toluene on promoted chromia–alumina catalysts were studied in flow systems. The effects of incorporating radioisotopes into the catalysts and of pre-irradiation with Co^{60} gamma rays were investigated. Magnesium sulfate and magnesium sulfate–sodium sulfate catalysts containing up to 45.5 mc S^{35} per gram were less active than nonradioactive catalysts of similar composition when compared on a unit surface area basis. The reduction in catalytic activity persisted even after the radioactivity had substantially decayed. Further, no change in catalytic activity was observed upon irradiation with x rays while the reaction was in progress. From these results it is concluded that the emission of beta particles from the catalyst during its use has no effect. Reports of an enhancement of catalytic activity may be attributed to the fact that, for a given set of preparation conditions, the radioactive catalysts have larger surface areas than their nonradioactive counterparts, and that this was not taken into account. Pre-irradiation with Co^{60} gamma rays to 10^{11} erg/g had no effect on the catalysts' activity. In contrast, pre-irradiation of the chromia–alumina catalysts with Co^{60} gamma rays to doses of 1.25 to 1.81×10^{11} ergs/g enhanced the catalytic activity by about 34% at 485°C, but incorporation of up to 148 mc Pm^{147} per gram of catalyst had little or no effect. No substantial effect of radiation on surface area or on apparent activation energy was observed in this case. (auth)

25341 COLOR CENTER FORMATION AT HIGH PRESSURES AND LOW TEMPERATURES. Douglas Beach Fitchen. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 113p.

The effect of hydrostatic pressure at low temperatures on the growth rate and optical absorption spectra of radioinduced color centers was studied for several alkali halides, using a cryogenic pressure cell fitted with appropriate x-ray and optical windows. The pressure dependence of the rate of growth of the F band was measured for KCl and KBr at liquid helium temperature, and for KCl, KBr, and NaCl at liquid nitrogen temperature, over a pressure range of 6000 atmospheres or more. The rate decreased exponentially with pressure, and the magnitude of the effect depended on the alkali halide. The results were analyzed in terms of activation volumes and effects due to the decrease in lattice space to show that the measured pressure shifts would imply unreasonably high effective "temperatures" for a thermally activated process in which Schottky vacancies are generated at dislocations. The results for KCl and NaCl were consistent with the data of Rabin and Klick, implying that a Frenkel defect mechanism, such as the Varley mechanism, is the dominant process at low temperatures. The larger effect for KBr was not consistent with either process alone, and the analysis suggested that coloration involves two mechanisms in this case, one of which is almost completely suppressed by pressure. Subsidiary measurements of the position and shape of the color center absorption bands produced under pressure are discussed. The multiplet structure of the F band previously observed in the CsCl-type alkali halides is shown to be related to the F band, since it shifts uniformly with pressure in CsCl. This multiplicity is not indigenous to the CsCl-type lattice structure, since an F band produced in the CsCl-type high pressure phase of RbCl at liquid helium temperature shows no such structure. (Dissertation Abstr. 23: May 1963)

25342 HOMO- AND COPOLYMERIZATION OF ETHYLENE INDUCED BY COBALT-60 GAMMA RADIATION. M. Steinberg and P. Colombo (Brookhaven National Lab., Upton, N. Y.). IAEA Preprint No. CN-14/24. 36p. (TID-18793)

To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, held in Salzburg, Austria, May 27-31, 1963.

The kinetics of the polymerization of ethylene gas induced by Co^{60} gamma radiation were determined by a continuous recording falling pressure technique. The rate of polymer formation, Q, in gm/l/hr expressed in terms of the pressure, P, in atmospheres, and the radiation intensity, in rad/hr, for the pressure region of 150 to 600 atm, the intensity region of 17,000 to 920,000 rad/hr, and at a temperature of 30 to 50°C, was determined to be $Q = 6.26 \times 10^{-4} P^{1.02} I^{0.42}$. Generally, the polymers show intermediate density values, possess a high degree of crystallinity after annealing, and at lower total dose exposures are non-cross-linked. Experiments were undertaken on the random copolymerization of ethylene gas up to pressures of 680 atm with a number of liquid and gaseous monomers in a Co^{60} radiation field. Reasonable identification and characterization of a number of copolymers of ethylene were made, among which are carbon monoxide, polyvinyl chloride, poly-

vinyl acetate, acrylonitrile, and chlorotrifluoroethylene. A radioinduced reaction at 20°C leading to a thermal reaction and explosive decomposition with the formation of carbon was observed in the $CClF_3-C_2H_4$ system. (P.C.H.)

25343 STUDIES OF RADIATION MECHANISMS AS APPLIED TO POTENTIAL MANUFACTURING PROCESSES: HYDRAZINE FROM AMMONIA AND RELATED SYSTEMS. F. W. Lampe, W. S. Koski, E. R. Weiner, and William H. Johnston (Johnston (William H.) Labs., Inc., Baltimore). IAEA Preprint No. CN-14/23. 22p. (TID-18795)

To be published in proceedings of Conference on the Application of Large Radiation Sources In Industry held in Salzburg, Austria, May 27-31, 1963.

Studies were made on the production of hydrazine from ammonia, fixation of nitrogen, and production of ozone from oxygen by radiolysis. The yield of hydrazine from the irradiation of ammonia mixed with Kr was about four times that found for pure ammonia and 15 to 20 times that found for ammonia mixed with neon. A G-value of 2.2 was found for the formation of hydrazine in the irradiation of a mixture of ammonia and Kr. It was found that irradiation of N–O mixtures caused NO, N, NO^+, N_3^+, and N_4^+ to be formed immediately (at the rate of ion–molecule reaction). The mechanism and assessment of potentialities for the formation of ozone in the radiolysis of oxygen are discussed. (P.C.H.)

25344 METHOD OF PRODUCING EMISSIVE LAYERS AND EMITTERS, IN PARTICULAR STRONTIUM AND RADIUM, BY MEANS OF ELECTROLYSIS FROM ORGANIC SOLUTION FOR DOSIMETRIC PURPOSES, NO-CONTACT MEASURING, NEUTRALIZATION OF ELECTROSTATIC CHARGES, AND THERAPEUTIC PURPOSES. Rudolf Bischof and Karel Papež. Czechoslovak Patent 9982. Apr. 15, 1961.

The method suggested is distinguished by the fact that with electrolysis the voltage is gradually increased to 100 to 10000 v, for example, production of emitters containing Sr^{90}. Sr is converted into a compound dissolvable in a chosen organic solvent (Sr sulfo-cyanide in acetone). In the electrolysis of the solution, a layer of $Sr^{90}CO_3$ is deposited on the cathode owing to a gradual increase in voltage up to several kv. The activity obtained per unit area is a function of the initial concentration of the salt and of the voltage. In a similar way it is possible to produce emitters of various types (particularly in the form of needles) containing Ra or active Ca and Ba isotopes. (Referativnyy zhurnal, Khimiya, No. 17, 1962)

25345 METHOD FOR PRODUCING ATOMIC HYDROGEN. Frederick W. Lampe (to Esso Research and Engineering Co.). U. S. Patent 3,092,561. June 4, 1963. Filed Jan. 20, 1960.

A method for producing atomic H is described which comprises irradiating a mixture of H_2, a gaseous radiation acceptor, and a gaseous H atom acceptor. The radiation acceptor may be a rare gas, N_2, or CO, and the H atom acceptor, any organic or inorganic compound which will react with H atoms. Product yields are given for the radiolysis of $C_2H_4-H_2$ mixtures containing various amounts of a radiation acceptor. (D.L.C.)

Raw Materials and Feed Materials

Refer also to abstract 26191.

25346 (MCW-1478) THE INTEGRATED FLUID-BED SYSTEM. A Summary of the Development Work Concerning: Fluid-Bed Denitration, Fluid-Bed Reduction, Fluid-Bed Hydrofluorination. S. Simecek and W. T. Trask (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). June 10, 1963. Contract W-14-108-eng-8. 126p.

For the production of high-quality UF_4 from pure uranyl nitrate, the operability of a continuous process was demonstrated in pilot-scale fluid beds. The three separate fluid-bed-reactor systems that, respectively, denitrate, reduce, and hydrofluorinate were integrated. Correlations of the operating variables within each system were developed. In the denitrator, these data permit the prediction of such factors as heat transfer and product particle size for various operating conditions. The fluid-bed denitrator was operated successfully with uranyl nitrate feed concentrations as high as 11.8 lb of U/gal and at UO_3 production rates greater than 350 lb/hr-sq ft of reactor cross section. In the fluid-bed reduction reactor, 100 lb of UO_2/hr-cu ft of active reactor volume is a satisfactory productivity, and the important operational variables at this production rate are bed temperature and hydrogen-excess. For the hydrofluorination reaction, a single-stage fluid-bed reactor was found unsatisfactory both as to product quality and reactor operability. Both of these requirements, however, were met in a two-stage fluid-bed system. High-quality UF_4 was produced in tonnage quantities and at rates as high as 73 lb/hr. The results described and the conclusions drawn indicate that the integrated fluid bed is an economical and efficient system for converting uranyl nitrate to uranium tetrafluoride. The productivity of the denitration is much greater than the target during the original design and the product is now readily processed in screw reactors as well as the fluid-bed system. The evolved reduction-hydrofluorination system has a capacity 50% greater than its original design and will produce high-quality UF_4 even under nonideal conditions. (auth)

25347 (NLCO-872) HIGHLIGHTS RESEARCH AND DEVELOPMENT ACCOMPLISHMENTS 1959–1962. R. Burgett (National Lead Co. of Ohio, Cincinnati). Mar. 25, 1963. Contract AT(30-1)-1156. 34p.

The production of uranium from ores and concentrates, fabrication of uranium reactor fuel tubes, development of uranium processes and equipment, and processing of uranium concentrates are briefly discussed. (N.W.R.)

25348 CATALYTIC PROPERTIES OF ALPHA U_3O_8 IN DEHYDROGENATION AND DEHYDRATION REACTIONS; BOND ENERGIES OF CARBON, HYDROGEN, AND OXYGEN WITH THE CATALYST. A. A. Tolstopyatova, Z. Dudzik, and A. A. Balandin (Moscow State Univ.). Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, No. 4, 616-19(Apr. 1963). (In Russian)

Kinetics of dehydrogenation and dehydration of isopropyl alcohol and tetralin dehydrogenation on $\alpha-U_3O_8$ were studied. A mixed action $\alpha-U_3O_8$ catalyst dehydrogenates and dehydrates isopropyl alcohol and dehydrogenates tetralin. Catalytic properties of $\alpha-U_3O_8$ dehydrogenation and dehydration are similar to ThO_2 properties. (R.V.J.)

25349 URANIUM RECOVERY PROCESS. John C. Hillyer and Loy D. Sneary (Phillips Petroleum Co.). U. S. Patent 3,086,840. Apr. 23, 1963. Filed Jan. 20, 1958.

A solvent extraction process is patented for recovery of soluble uranium complex anions from aqueous leach solution with a minimum of loss of extracting medium. The leach solution is contacted with a liquid organic extracting medium comprising a liquid copolymer of an open-chain aliphatic conjugated diene and a heterocyclic nitrogen-base monomer in an organic solvent substantially insoluble in

water. The solids of slimes and pulps can be separated from the organic extracting agent by sedimentation, and U-containing anions are desorbed from the extracting agent with regeneration of the ion-exchange material. Variations in the chemical composition of the extracting medium are described. (M.P.G.)

25350 METHOD FOR PREVENTION OF PLUGGING OF AERATION TUBES IN THE LEACHING OF URANIUM ORES. James L. Hart and Robert E. Reusser (to Phillips Petroleum Co.). U. S. Patent 3,086,841. Apr. 23, 1963. Filed Oct. 21, 1959.

The plugging of the aeration tubes, which introduce air into vessels where U-containing ores are being leached, can be prevented by coating the tubes on their internal surfaces with an organic silicon compound. The leaching of U ores in autoclaves or Pachuca tanks is described, and 4 chemical formulas are given for the organic silicon compounds that will prevent plugging. (M.P.G.)

25351 FLUORINATION AND OXIDATION OF URANIUM TETRAFLUORIDE TO URANIUM HEXAFLUORIDE BY PERCHLORYL FLUORIDE. William A. La Lande, Jr. (to Pennsalt Chemicals Corp). U. S. Patent 3,086,842. Apr. 23, 1963. Filed July 1, 1960.

When UF_4 is contacted with ClO_3F at elevated temperatures under anhydrous conditions in the absence of an added source of O, the UF_4 is converted by a combination of fluorination and oxidation reactions to a mixture of UF_6, UO_2F_2, and Cl_2. The UF_6 and Cl are readily separated as volatile materials from the UO_2F_2, and the Cl is easily separated from the UF_6, which forms a sublimate. The process is described in detail. (M.P.G.)

25352 TREATMENT OF URANIUM ORE. Allen D. Garrison (to Texaco Inc.). U. S. Patent 3,087,780. Apr. 30, 1963. Filed Dec. 22, 1958.

A method of separating U from its ores is patented. Pulverulent U ore is contacted with ammonium fluoride or ammonium bifluoride in the presence of a free-oxygen-containing gas at a temperature of at least 400°F. Uranyl ammonium pentafluoride is formed and is separated as a vapor from the solid ore residue. The vapor is then condensed on cooled metal pipes or walls or by contacting with cool pulverulent solids. (M.P.G.)

25353 RECOVERY OF THORIUM OXALATE FROM SULPHURIC ACID LEACH LIQUOR CONTAINING DISSOLVED THORIUM, RARE EARTHS, AND PHOSPHATE. Gillian Mary Carter, David Anthony Everest, and Ronald Alfred Wells (to United Kingdom Atomic Energy Authority). U. S. Patent 3,087,948. Apr. 30, 1963. Priority date Aug. 26, 1957, Great Britain.

A solid Th concentrate may be recovered from an aqueous sulfuric-acid leach liquor obtained from a Th- and phosphate-bearing ore by the addition of oxalic acid to the solution. By controlling the acid normality of the solution between 4 and 6.5 N with respect to sulfuric acid, and by controlling the molar proportion of oxalic acid to dissolved Th in the leach-liquor solution between 3:1 and 5:1, a precipitate containing a high yield of Th and a relatively low ratio of rare earths to Th is obtained. (M.P.G.)

25354 PRODUCTION OF URANIUM METAL. James Elgie Lloyd and Donald Duxbury (United Kingdom Atomic Energy Authority). U. S. Patent 3,088,822. May 7, 1963. Priority date Jan. 22, 1959, Great Britain.

A method for the production of U metal by the reduction of uranium tetrafluoride is patented. UF_4 is compacted with magnesium metal, and the reactants are heated in a reaction vessel to a temperature below the reaction initiation temperature while evacuating the vessel. The heating is continued to the reaction initiation temperature under a blanket of inert gas at a pressure of ~10 to 15 lbs above atmospheric pressure. This results in improved reaction efficiency and improved life of the graphite, which lines the reaction vessel. (M.P.G.)

25355 RECOVERY OF URANIUM FROM LIGNITE. Harold A. Green (to Air Products and Chemicals, Inc.). U. S. Patent 3,092,445. June 4, 1963. Filed Oct. 21, 1958.

A process is given for extracting U from uncalcined lignite in a form suitable for further processing. The process comprises contacting the dry lignite with an aqueous solution of acetic or carbonic acid buffered with an acetate or bicarbonate salt. The resulting extract is clear, easily filtered, and contains a high U content, and it may be treated for U recovery by alkaline precipitation or solvent extraction. (D.L.C.)

25356 TREATMENT OF URANIUM ORES FOR RECOVERY OF THE URANIUM CONTENT THEREOF. Denis Ivor Legge and Maxwell Lipworth (to Anglo-Transvaal Consolidated Investment Co.). U. S. Patent 3,092,447. June 4, 1963. Filed Aug. 3, 1959.

A process is given for the recovery of U from U ores by dissolution, oxidation of the U to the soluble uranyl form, and separation of U by ion exchange or other means. In this process, the filtered pulp is divided into two streams, one of the streams is stirred to form a vortex, and O_2 and SO_2 are passed through the vortex to form ferric sulfate and sulfuric acid. This stream is recirculated to the ore for dissolution and oxidation, while the other stream is treated for U recovery. (D.L.C.)

Separation Processes

Refer also to abstracts 24768, 25529, 25530, 26189, 26190, 26213, 26778, and 26784.

25357 (NP-12804) FIRST REPORT ON THE ACTIVITIES OF THE EUROCHEMIC COMPANY, 1959–1961. (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium and European Nuclear Energy Agency, Paris). 381p.

Eurochemic, one of the joint undertakings of the European Nuclear Energy Agency, is an international shareholding company created, under a convention signed in Paris on December 20, 1957, by the governments of 12 European countries and later joined by another. Information is presented on its organization, structure, staff, administration, finances, construction, design, operation, technical aspects of the plant, research and development work to be carried out, ways of collaborating with industry, external relations, circulation of information, and the company's policy. (N.W.R.)

25358 (SRO-70) DEVELOPMENT OF SEPARATION PROCEDURES FOR RADIOACTIVE MATERIALS. SODIUM, BARIUM, CALCIUM, AND STRONTIUM DISTRIBUTION COEFFICIENTS IN A DI-2-ETHYL HEXYL PHOSPHORIC ACID SOLVENT EXTRACTION SYSTEM. Annual Technical Status Report No. 3, April 1, 1961 to March 31, 1962. Robert J. Klett (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). May 15, 1962. Contract AT(38-1)-202. 249p.

The system di-2-ethylhexyl phosphoric acid (D2EHPA) in Amsco 125-82 diluent is evaluated for the separation of the Group II elements barium, strontium, and calcium in the presence of sodium. The system variables investigated are pH, D2EHPA organic phase concentration, ionic con-

centration of Group II element with varying sodium concentration, and the intereffect of two Group II ions present on extraction characteristics. The range over which the variables are studied are: pH, 0 to 6; D2EHPA concentration, 0.1 to 1.6M; Group II element concentration, 0.003 to 0.2M; and sodium concentration 0.1 to 5M. In the runs made the system response as indicated by the distribution coefficient, aqueous phase molar concentration, and organic phase molar concentration is reported. Correlation of the extraction data is underway utilizing the Burroughs 220 Datatron digital computer. (auth)

25359 (AEC-tr-5811) TREATMENT OF IRRADIATED FUELS BY VOLATILIZATION OF FLUORIDES. P. Faugeras. Translated for Oak Ridge National Lab. from a French Paper Presented at the Symposium on Aqueous Reprocessing Chemistry for Irradiated Fuels, held in Brussels, April 23-26, 1963. 41p.

The history, development, principles, problems, and methods for separating plutonium and uranium from irradiated fuels by fluoride volatility processes are reported. The types of irradiated fuels investigated are: Zircaloy-2-clad uranium–zirconium alloy, aluminum-clad aluminum–uranium alloy, aluminum-clad molybdenum–uranium alloy, stainless steel-clad uranium dioxide, and stainless steel-clad plutonium dioxide–uranium dioxide systems. (N.W.R.)

25360 (EURAEC-570) REPROCESSING OF IRRADIATED FUELS. Final Report. S. Schmets, G. Camozzo, A. Francesconi, R. Heremans, G. Pierini, Ph. Speeckaert, S. Van Vlasselaer, J. Broothaerts, C. Lambiet, and J. Vandersteene (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire). 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 008-60-4/RDB. 108p. Translation of EUR-82.f.

Various halogenation reprocessing cycles for ceramics were studied. The process UO_2 (sintered) → U_3O_8 → UO_2 → UF_4 → UF_6 was considered both from the fundamental and technological points of view. The successive reactions are performed in fluid beds. They allow distribution of the total heat of transformation into UF_6 over several steps. The first of these, the oxidation of sintered UO_2 into U_3O_8, leads to the formation of a powder with favorable characteristics for the subsequent gas-solid reactions; the preliminary hydrofluorination of UO_2 permits a decrease in the elemental fluorine consumption needed to produce UF_6. Basic information was also collected for a number of new UO_2 and UC reprocessing cycles. The oxidation and hydrofluorination of uranium monocarbide, the ceramic transformation into UO_3, and the chlorination of uranium carbide and oxide are reactions which can be performed with good yields. Laboratory scale experimental studies on the decontamination factor during the fluorination reprocessing cycle showed a sharp separation between uranium and fission products. On the contrary, the chlorination of uranium compounds into volatile uranium chlorides gives only a low decontamination factor which, however, may be sufficient if remote fuel fabrication techniques are used. (auth)

25361 THE EFFECT OF ADDITIVES AND STABILIZERS ON THE EXTRACTION BEHAVIOUR OF U(VI) AND Pu(IV) NITRATES WITH TERTIARY AMINES. F. Baroncelli, G. Scibona, and M. Zifferero (CNEN, Rome and Università, Rome). J. Inorg. Nucl. Chem., 25: 205-13(Mar. 1963).

The use of additives and stabilizers in the solvent extraction of actinides with tertiary amines to control the third phase formation and the Pu valence state introduces new variables in the solvent extraction behavior of these elements. The effect of the separate presence of nitrous acid as a stabilizer and of a long chain aliphatic alcohol as an additive was evaluated for uranyl and plutonium nitrate. Depending on the acidity of the aqueous solution the addition of nitrite to the water phase can depress or enhance the partition coefficients. The addition of a long chain alcohol has only a depressing effect. When the additive and the stabilizer are present at the same time, the partition coefficient is a maximum when equal molar concentration of alcohol and nitrous acid are added to the organic phase. A coherent interpretation of this behavior is given. (auth)

25362 REAGENT DEPENDENCE IN SODIUM AND STRONTIUM EXTRACTION BY DI(2-ETHYLHEXYL) PHOSPHORIC ACID. W. J. McDowell and C. F. Coleman (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 25: 234-5(Mar. 1963).

In the extraction of Sr from $NaNO_3$ solutions by di(2-ethylhexyl)-phosphoric acid (HX) in benzene, the extraction coefficient is proportional to $[HX]^2$ and $1/[H^+]$ for Na extraction and to $[HX]^3$ and $1/[H^+]^2$ for Sr extraction. These dependences may be explained by the reactions $Na^+ + 2(HX)_2 \rightleftharpoons NaX \cdot 3HX + H^+$ and $Sr^{2+} + 3(HX)_2 \rightleftharpoons SrX_2 \cdot 4HX + 2H^+$. (D.L.C.)

25363 SOME ASPECTS OF SYNERGISM IN SOLVENT EXTRACTION. I. URANIUM(VI). M. Zangen (Israel Atomic Energy Commission, Rehovoth). J. Inorg. Nucl. Chem., 25: 581-94(May 1963). (TID-16152; UAC-6419)

Synergistic extraction of U(VI) from 0.3N HCl was studied, using combinations of a monoacidic phosphate or phosphonate ester (the chelating agent) with a neutral organophosphorus compound (the synergist) at varying concentrations in benzene or cyclohexane. A correlation was found between the acid strength of the chelating agent and its performance in synergistic extraction. From the anti-synergistic slope and the concentration of neutral synergist yielding the maximum distribution ratio, the formula of the extracted species and the constants governing the extraction equilibrium are derived. (auth)

25364 PROPERTIES OF INORGANIC ION EXCHANGERS WITH A ZIRCONIUM BASE AND OF CLAY MINERALS. H. J. Riedel (Kernforschungsanlage, Julich, Ger.). Nukleonik, 5: 48-54(Feb. 1963). (In German)

Comparative studies were made on the exchange capacities and distribution coefficients of inorganic exchangers with a zirconium and a hafnium base (phosphate, tungstate, and molybdate) and with the clay minerals glaukonite, "Pelagic Clay," and montmorillonite. The K_p values for the ions Na^+, K^+, Rb^+, Cs^+, Fr^+, Ca^{2+}, Sr^{2+}, Sc^{3+}, Y^{3+}, and Ce^{3+} were determined for these materials and for a synthetic ultramarine. A series of ion separations was carried out. Among others, a Ca^{2+}–Sc^{3+} separation on radioresistant zirconium molybdate, which is of interest for the preparation of carrier-free Ca^{45}, was carried out. The minerals were shown to be, as was known of exchangers with a Zr basis, very specific exchangers for Cs^+ ions. The pH dependence of the exchanger properties was studied in detail, and an attempt was made to predict the most suitable conditions for radiochemical separations in dependence on the selectivity coefficients (K_S values). An interesting "reversal effect" was observed in the affinity sequence with respect to the ion pair Sr^{2+}–Y^{3+} on zirconium phosphate and even on zirconium tungstate. This effect can be used for the preparation of radioyttrium by elution of a Sr^{90}-charged microcolumn. A "reversal effect" was not observed on zirconium molybdate. The basis for the decrease of the Y^{3+} yield after repeated elutions ("Y^{90} milking") is discussed. (tr-auth)

25365 EXTRACTION OF ZIRCONIUM AND HAFNIUM FROM NITRIC AND HYDROCHLORIC ACID SOLUTIONS BY n-TRI-BUTYL PHOSPHATE. A. M. Reznik, A. M. Rozen, S. S. Korovin, and I. A. Apraksin. Radiokhimiya, 5: 49-59(1963). (In Russian)

Distribution and separation coefficients of Zr and Hf extraction by TBP are studied as functions of the metal concentration relative to the concentration of nitric and hydrochloric acids. The extraction of macroquantities of Zr and Hf from nitric acid and hydrochloric acid and mixed solutions was investigated at Zr concentration to 0.5M and Hf to 0.18M. It was found that with an increased metal concentrations the extraction constants diminish (especially in strong nitric solutions) because of polymerization. Polymerization constants were estimated. Replacement of nitric acid by hydrochloric acid enhances Zr distribution constants to a maximum and for Hf the replacement of nitric acid by hydrochloric depresses the extraction. (R.V.J.)

25366 SORPTION OF URANIUM(VI) FROM SOLUTIONS CONTAINING HYDROFLUORIC ACID BY HIGHLY ACID CATION KU-2. V. S. Pakholkov. Radiokhimiya, 5: 59-62(1963). (In Russian)

Dynamic sorption of U(VI) by KU-2 cationite from hydrochloric and sulfuric acid solutions with and without fluorine ions was investigated and the depressing effects of fluorine ions on uranium sorption were determined. Studies of U(VI) sorption from UO_2F_2 as a function of the hydrofluoric acid concentration by KU-2 in H^+ and NH^+ form showed that UO_2F_2 is sorbed as a simple ion. (R.V.J.)

25367 APPLICATION OF ION EXCHANGE IN STUDIES OF SUBSTANCES IN SOLUTIONS. IX. STUDIES OF EUROPIUM COMPLEX FORMATION WITH CERTAIN DIBASIC ACIDS. V. I. Paramonova, A. S. Kereichuk, and A. V. Chizhov. Radiokhimiya, 5: 63-73(1963). (In Russian)

Complex formation of Eu with malonic, maleic, and oxalic acids with variable pH and constant ionic force was studied. At high pH (> 4.0) the complexing is determined by the second step of acid dissociation. Stability constants of $[Eu\ Malon]^+$, $[Eu\ Mal]^+$ and $[Eu\ Ox]^+$ are tabulated and analyzed. (R.V.J.)

25368 SCREENING EXPERIMENTS IN SOLVENT EXTRACTION OF ZIRCONIUM BY TRIBUTYL PHOSPHATE. Yu. V. Granovskii, V. V. Nikishova, Yu. P. Adler, V. V. Nalimov, and L. N. Komissarova (Moscow State Univ. and State Research and Construction Inst. of Rare Earth Metallurgy, USSR). Zavodsk. Lab., 29: 321-6(1963). (In Russian)

A random balance method was used for screening the dominant effects in Zr extraction from nitric acid by tributylphosphate. 78 effects were screened and studied. (tr-auth)

25369 MATHEMATICAL METHODS IN ORGANIZING EXPERIMENT STUDYING ZIRCONIUM EXTRACTION MECHANISMS. L. N. Komissarova, Yu. V. Granovskii, N. M. Prutkova, Yu. P. Adler, and V. V. Nalimov (Moscow State Univ. and State Research and Construction Inst. of Rare Earth Metallurgy, USSR). Zavodsk. Lab., 29: 327-30(1963). (In Russian)

Mathematical statistics were used to verify three competing equations suggested a priori for describing the process of zirconium extraction from nitric acid solutions by tributylphosphate. (tr-auth)

25370 EXTRACTION OF ZIRCONIUM AND HAFNIUM FROM MIXTURES OF NITRIC AND PERCHLORIC ACIDS BY TRIBUTYL PHOSPHATE. S. S. Korovin, K. Dedich, E. N. Lebedeva, and A. M. Reznik (Moscow Inst. of Fine Chemical Tech.). Zh. Neorgan. Khim., 7: 2475-7(Oct. 1962). (In Russian)

The results of experiments on extraction of zirconium and hafnium by 50% tributyl phosphate in o-xylene showed a strong dependence on the nitric acid/perchloric acid mole ratio in the aqueous phase. With a total acidity of 6M, in the absence of nitric acid extraction of both elements was insignificant. At a ratio of 1/5, the zirconium distribution coefficient was 320 and that of hafnium, 21, these being the maximum values reached. With further increase in the nitric acid and decrease in the perchloric acid, both distribution coefficients dropped, the zirconium more rapidly than the hafnium, to approximately zero again when the perchloric acid concentration was zero. The possibility is suggested that mixed complexes, of the type $Zr(NO_3)_x(ClO_4)_{4-x} \cdot 2TBP$, are formed, which are readily extractable. It is also considered probable that in solutions containing perchloric acid the degree of polymerization of zirconium nitrate is less than in nitric acid solution. (TTT)

25371 SORPTION OF METALS FROM ACETATE SOLUTIONS BY ACTIVATED SKT COAL. I. A. Kuzin, V. P. Taushkanov, and B. Boshina. Zh. Prikl. Khim., 36: 604-8(Mar. 1963). (In Russian)

Studies of U, Ce, Th, Fe, and Mg sorption from acetic and perchloric acids by activated coal were carried out. A higher sorptive capacity of coal for U in acetic acid was found, and the ability to form stable complexes in acetate solutions is reported. (R.V.J.)

25372 HET SYSTEEM: URANYLNITRAAT–WATER–TRIBUTYLFOSFAAT–TETRACHLOORKOOLSTOF. (The System Uranyl Nitrate–Water–Tributylphosphate–Carbon Tetrachloride). Jacobus Johannes Van Aartsen. Thesis, Delft, Netherlands, Technische Hogeschool, 1962. 110p.

The extraction of uranyl nitrate from aqueous solutions by mixtures of tri-n-butyl phosphate (TBP) and carbon tetrachloride is governed by the equilibrium compositions on either side of the miscibility gap in the quaternary system $UO_2(NO_3)_2–H_2O–TBP–CCl_4$. Thermodynamic descriptions of nonideal behavior in binary and ternary mixtures are first discussed. The materials used, their most important physical constants, and the purification procedures applied in the measurement of the equilibrium concentrations are surveyed. The values determined at 25°C for the equilibrium concentrations and the vapor pressures in the $CCl_4–H_2O–TBP$ and $UO_2(NO_3)_2–H_2O–TBP$ systems are reported. The results for the quaternary system are shown in tables and in diagrams. The effect of nitric acid on the extraction of $UO_2(NO_3)_2$ with pure and diluted TBP is determined. The effect of other variables important in an effective extraction scheme is also considered. (J.S.R.)

25373 STUDIES OF ANALYTICAL SEPARATIONS. Darrell James Donaldson. Thesis, Baton Rouge, La., Louisiana State Univ., 1962. 85p.

Solvent extraction was extensively applied to the separation of cations but its application to anion separation was for the most part ignored. A study was undertaken to determine the conditions under which the extraction of thiocyanate was favorable. Different solutions of thiocyanate were shaken with 1:1 tri-n-butyl phosphate (TBP)–methyl isobutyl ketone (MIBK), and after separation of the layers the aqueous phase was colorimetrically analyzed for thiocyanate. Zinc was chosen as a coordinating metal ion to form extractable ion association species with thiocyanate. Addition of zinc in various concentrations was found to have no effect on the extraction. The distribution ratio

rose with increasing nitric acid concentration until a constant value was reached at 1M. The extractability of thiocyanate was found to increase with decreasing temperature and with increasing thiocyanate concentration. Recovery and subsequent determination of thiocyanate was achieved by shaking the organic phase with potassium hydroxide after it was treated with carbon tetrachloride. Coextraction and selectivity of the system were studied with regard to eighteen anions. Molecular thiocyanic acid was responsible for the extraction. The extracting species was TBP.HNCS. Improvements on the qualitative analysis scheme devised by West and Vick were made. Calcium, strontium, and bismuth were found to be troublesome in the analysis scheme of West and Vick. (TCO)

25374 FUEL ELEMENT RECOVERY PROCESS. James R. Johnson and William E. Rowe (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,087,779. Apr. 30, 1963. Filed June 25, 1958.

An oxidative-slagging process for recovering radioactive and fissionable products from carbon is patented. Graphite-encased uranium-containing nuclear fuel elements or fuel elements of the ceramic carbonaceous type are oxidized in an inert atmosphere containing ~3 to 7 vol % of oxygen at a temperature of ~1550 to 1650°F and under conditions of nonself-sustaining combustion. The process results in a controlled decomposition of the fuel element, leaving the solid products of oxidation quantitatively at the location of the oxidation and easily available for recovery. (M.P.G.)

25375 EXTRACTION OF A METAL FROM SOLUTIONS CONTAINING SAME. Charles A. Fetscher (to Nopco Chemical Co.). U. S. Patent 3,088,798. May 7, 1963. Filed May 25, 1959.

A heavy metal can be removed from a solution by bringing the solution into contact with a chelating agent, polyamidoxime, which is a high-molecular-weight organic polymer containing amidoxime substituents. During contact between the solution and the chelating agent, the amidoxime groups and the metallic ions react to form a complex, thereby withdrawing substantially all of the ions from the solution. The ions can be removed from the complex and recovered, if desired, and the chelating agent is regenerated simultaneously. The preparation of the chelating agents and the regeneration of the polyamidoximes are described. Specific examples of the extraction of heavy metals, including Au, Cu, and U, are presented. (M.P.G.)

25376 METAL EXTRACTION PROCESS. Charles A. Fetscher (to Nopco Chemical Co.). U. S. Patent 3,088,799. May 7, 1963. Filed May 25, 1959.

A process is patented, by which heavy metals may be selectively extracted from solutions by bringing the solution into contact with a chelating agent, solid polyamidoxime. The chelating agent will form complexes with a selected group of heavy metals of atomic weight greater than 50. Heavy metal ions can thus be removed from solutions containing mixtures of heavy metal ions and lighter ions. It is also possible to extract one or several heavy metals from a solution containing a mixture of heavy metal ions, all of which are capable of extraction, and to elute selectively from the complex one or several of the ions. The complexes, which are formed by the various metals with the polyamidoximes, vary in their stability to acids, and therefore adjustment of the pH of the solution makes it possible to separate the various metals in solution from each other. The recovery of the extracted metal from the complex and the preparation of the chelating agents are described. (M.P.G.)

25377 SEPARATION OF PLUTONIUM FROM URANIUM. William W. Morgan, Wilson G. Mathers, and Robert G. Hart (to Atomic Energy of Canada Ltd.). U. S. Patent 3,092,446. June 4, 1963. Filed Nov. 25, 1958.

A three-column extraction process using tributyl phosphate is outlined for the effective separation of Pu from irradiated U. Means is provided for delaying the flow of solvent extractant to permit the Pu dibutyl phosphate complex to be converted into the tributyl phosphate complex for easier stripping from the solvent. (D.L.C.)

25378 PROCESS FOR THE RECOVERY OF EUROPIUM FROM LOW GRADE EUROPIUM MIXTURES WITH OTHER RARE EARTHS. Kazimierz Jozef Bril, and Jose Behmoiras Madjar. U. S. Patent 3,092,449. June 4, 1963. Priority date July 22, 1958, Brazil.

The process comprises forming a solution of the rare earth sulfates, reducing the solution with zinc dust at a pH of 1 to 2.5 in the absence of O_2, and adding sodium or potassium sulfate to precipitate the rare earth double alkali sulfates. For rare earth mixtures such as in monazite, precipitation of 5 to 10% of the total rare earths is sufficient to precipitate 95 to 99% of the europium. (D.L.C.)

25379 PRECIPITATION OF ZIRCONIUM AND FLUORIDE IONS FROM SOLUTIONS. Billie J. Newby (to U. S. Atomic Energy Commission). U. S. Patent 3,093,452. June 11, 1963.

A process is given for removing zirconium and fluorine ions from aqueous solutions also containing uranium(VI). The precipitation is carried out with sodium formate, and the uranium remains in solution. (AEC)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstracts 24817, 25916, 26129, and 26130.

25380 (57GL125) DESIGN OF PERISCOPES AND REMOTE VIEWING EQUIPMENT. J. Holeman (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Apr. 2, 1957. 40p.

A non-technical survey of the design features and limitations of industrial periscopes, including stereoscopic, with emphasis on remote control is presented. Also included are photographic instruments, effects of radiation on optical materials, television applications, and other types of viewing equipment. (P.C.H.)

25381 (ASD-TDR-62-811) THERMAL ANALYSIS OF A SUPERCONDUCTING GENERATOR. Final Report. Robert J. Smith (Aeronautical Systems Div. Flight Accessories Lab., Wright-Patterson AFB, Ohio). Oct. 1962. 19p. (AD-288917)

The investigation was undertaken to establish heat transfer design data for a superconducting generator. An analysis was made of heat transfer via various leakage paths into the generator. Further, a method of computing the heat input from the load-connecting electrical leads was devised. The result was a set of calculations for one design and a method of optimizing the conductor for minimum heat transfer. (auth)

25382 (ASD-TR-61-705) RESEARCH ON HIGH-TEMPERATURE BEARINGS. R. D. Brown, R. A. Burton, and P. M. Ku (Southwest Research Inst., San Antonio). Nov. 1961. Contract AF 33(616)-7209. 71p. (AD-288892)

Evaluation work performed on oscillating bearings of both plain journal and self-aligning types is described. Bearing substrate materials include cermets LT-1B and LT-2 and alloys F-48 and Rene 41. Lubricants receiving extensive evaluation are a clad silver–palladium alloy, molybdenum disulfide used in cavities, and bonded molybdenum disulfide. Results include those from friction and wear evaluations, radial load capacity tests on plain journal bearings, and axial and radial load capacity tests on self-aligning bearings. The bearing specimens have a nominal diameter of ½ inch. Friction and wear tests are at an oscillating frequency of 31 cpm, at −90 to 1750°F, and at 10^{-6} to 10^{-5} mm Hg. The bearing load is 4,400 to 12,000 psi. (auth)

25383 (LADC-5792) PROBLEMS IN THE OPERATION OF LARGE CRYOGENIC SYSTEMS. F. Edeskuty, D. Liebenberg, and J. Novak (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 28p.

Two liquid-hydrogen test facilities were operated for fourteen months. These cells have the capability for transfer of liquid hydrogen at flow rates up to 100 lbs/sec and have a total storage capacity for liquid hydrogen of 156,000 gallons. A number of design and operational problems were met, for example, stresses in 8-in. diameter transfer lines, times and quantities of liquid hydrogen required for cool-down of transfer lines, dewar instrumentation, gas requirements for pressurization of liquid hydrogen filled dewars, and techniques for warmup of large cryogenic dewars. Solutions to many of these problems are described and outstanding problems discussed on the basis of current observations. In addition, some techniques are described that are employed for safe operation of the liquid hydrogen facility, including helium block systems for leaky valves, room inerting to prevent fire or explosion in the event of a hydrogen leak, and the purity control of dewar pressurizing gases and the purity control of purges of gas and liquid hydrogen transfer lines. A summary is included of major modifications that are planned or underway for these test facilities. (auth)

25384 (NAA-SR-7455) THEORY, DESIGN, AND PERFORMANCE OF HELICAL-ROTOR, ELECTROMAGNETIC PUMP. R. S. Baker (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 31, 1963. Contract AT(11-1)-Gen-8. 121p.

Pumps for liquid-metal coolants used in nuclear power reactors must be capable of reliable operation under conditions unique to this service. A helical-rotor electromagnetic pump was developed. This pump has no seals, no moving parts in the liquid-metal stream, is capable of low net positive suction operation without cavitation, can be mounted in any position, and is easy to control. A magnetic field set up by direct current flowing in windings on a rotor carrying skewed (helical) poles acts as the impeller. The liquid is confined to an annular space between two stainless steel cylinders. In performance tests on a scale model, the flow, efficiency, and pressure rise exceeded design predictions. A flow rate of 2200 gpm at a pressure of 34 psi and an efficiency of 26% was obtained when pumping sodium at a stream temperature of 600°F. The rotor winding current was 25 amperes at 175 volts d-c. The pump has operated over 1000 hours without loss of performance. (auth)

25385 (NASA-TN-D-1321) EXPERIMENTAL PERFORMANCE OF AN ION ROCKET ENGINE USING A RECTANGULAR-SLAB POROUS-TUNGSTEN EMITTER. Ronald J. Cybulski, Joseph T. Kotnik, and David L. Lockwood (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Nov. 1962. 26p.

An ion rocket engine using a porous-tungsten ionizer was operated for more than 50 hours. The techniques of electron-beam welding and high-temperature-furnace brazing were used to assemble the ionizer. Accelerator and power efficiencies of 90 and 70 percent, respectively, were obtained at a current density of 113 amp/sq m. The power efficiency was obtained at a specific impulse of 8680 seconds. Preliminary results indicate a propellant utilization efficiency of about 90 percent. (auth)

25386 (NESCO-P-166-10) EXPERIMENTAL STUDY OF THE EFFECTS OF REPEATED BLAST LOADINGS ON STRUCTURAL ELEMENTS. R. T. Eppink, L. B. McCammon, G. Hegemier, and L. A. Hoh (National Engineering Science Co., Pasadena, Calif.). May 1962. For Lockheed Missiles & Space Co., Sunnyvale, Calif. Contract NORD-17017, Subcontract 18-1250. 152p. (AD-284912)

An experimental study of the behavior of various structural elements subjected to repeated dynamic loadings is reported. The purpose of the investigation was to provide experimental evidence leading to a fuller understanding of the behavior of building structures which are exposed more than once to the blast waves of a nuclear explosion. The specimens tested include pinned and fixed-base rigid frames and portal-frame knee connections. All loadings, both static and dynamic, were applied by the atomic blast simulator at the U. S. Naval Civil Engineering Laboratory. The test results are presented and a comparison is made

with analytical calculations based on a simple structural theory. It was concluded from this comparison that the elementary theoretical procedures employed are adequate when applied to damage assessment studies. (auth)

25387 (ORNL-3442) TESTS OF HIGH-EFFICIENCY FILTERS AND FILTER INSTALLATIONS AT ORNL. E. C. Parrish and R. W. Schneider (Oak Ridge National Lab., Tenn.). June 3, 1963. Contract W-7405-eng-26. 46p.

High-efficiency filters are used in air-handling systems as the primary means of minimizing the amount of radioactive particulate matter released to the atmosphere. The filtration efficiency is successfully measured in situ using an aerosol of dioctyl-phthalate and a forward light scattering photometer. Tests are made to determine the linearity of the Naval Research Laboratory type photometer, the precision of filter efficiency determinations, the effect of prolonged exposure to aerosol on filtration efficiency, and the effect of airflow rate on the efficiency of both efficient and defective filters. (auth)

25388 (ORNL-TM-565) IN-CELL SOUND TRANSMISSION SYSTEM. R. E. McDonald and J. L. Wilson (Oak Ridge National Lab., Tenn.). June 12, 1963. Contract W-7405-eng-26. 17p.

To transmit sounds from the High Radiation Level Examination Laboratory (HRLEL) cells, a simple, rugged, and inexpensive sound system was developed, fabricated, and tested. The massive shielding walls effectively attenuate the in-cell sounds needed to monitor operations and minimize ennui. To conserve cell space and minimize cost and maintenance, a single unit was desired to provide both general and local listening. Standard components were adapted to the needs and conditions of remote manipulation. An omnidirectional microphone unit with wide-range response and good fidelity was molded into a radiation-resistant rubber jacket to aid in electrical coupling and protect against in-cell abuse. The pickup was connected to a wall jack, directly for general listening and through a specially designed jumper for local listening. The wall mount connected with an out-of-cell speaker that has a headphone attachment. Initial test results showed that use of the system in the HRLEL will reduce operator fatigue, decrease the need for equipment maintenance, and improve productivity. The design, criteria, operating performance, and cost of the portable system are presented with selected illustrations. (auth)

25389 (TID-18667) STEADY-STATE CHARACTERISTICS OF GAS-LUBRICATED, SELF-ACTING, PARTIAL-ARC, JOURNAL BEARINGS OF FINITE WIDTH. Interim Report. V. Castelli, C. H. Stevenson, and E. J. Gunter, Jr. (Franklin Inst. Labs. for Research and Development, Philadelphia). Apr. 1963. Contract Nonr-2342(00). 52p. (I-A2049-18)

A solution of the problem of self-acting, gas-lubricated, partial-arc, finite-length journal bearings for steady-state conditions is described. The results can be used for bearings of many types such as simple, fixed, partial-arc journal bearings (tapered land); axial-grooved journal bearings; pivoted-pad journal bearings; and similar geometric shapes. Sample results are plotted, and their utilization for various bearing types is illustrated by examples. (auth)

25390 (TID-18691) SOLUTION OF THE STABILITY PROBLEM FOR 360° SELF-ACTING, GAS-LUBRICATED BEARINGS OF INFINITE LENGTH. Interim Report. V. Castelli and H. G. Elrod, Jr. (Franklin Inst. Labs. for Research and Development, Philadelphia). Mar. 1963. Contract Nonr-2342(00). 161p. (I-A2049-20)

An investigation was made of the stability of self-acting, gas-lubricated bearings. Two approaches to the solution are presented and their results are compared. Also, the relation is discussed between this work and other, more simplified, methods available in the literature. The particular case of a 360° journal bearing of infinite length is treated, and the changes necessary to use the same theories with other geometries are pointed out. Available experimental results are collected and compared with theory. (auth)

25391 DEVELOPING ELECTRIC-PROPULSION POWERPLANTS. David G. Elliott (California Inst. of Tech., Pasadena). Astronaut. Aerospace Eng., 1: No. 5, 82-8(June 1963).

Auxiliary power supplies available now or in the future are discussed, and considerations involved in designing propulsion systems are examined. Basic problems in powerplant design are pointed out; and design and development of turboelectric, thermionic, and magnetohydrodynamic systems for converting heat to electrical energy are reviewed. (D.C.W.)

25392 REMOTE VIEWING FOR RADIATION ENVIRONMENTS. William F. Scharenberg, Jr. and Osmar A. Ullrich. Battelle Tech. Rev., 12: No. 6, 9-16(June 1963).

Special optical equipment has been evolved to enable viewing of operations and study of materials in hot-cell laboratories. A description is given of the characteristics of various remote viewing systems, and it is explained how systems can be adapted to various uses and how the effects of radiation on the apparatus can be mitigated. (auth)

25393 PHOTOELASTIC RESEARCH FOR THE PRESSURE VESSEL OF THE P.R.O. REACTOR. Aldo Mondina (Istituto di Costruzione delle Macchine del Politecnico, Milan). Comit. Nazl. Energia Nucl., Notiziario, 9: 35-41 (Apr. 1963). (In Italian)

The pressure vessel of the P.R.O. reactor, cylindrical in shape, is to be placed in a vertical position. The top will have an elliptical form and the bottom an ellipsoidal shape. Photoelastic tests were made on plane models having the same diameters and analogous arrangements as planned for the actual pressure vessel. Tests were also carried out on a tridimensional model having a 1:10 scale. The results obtained are briefly reported. (J.S.R.)

25394 STRESS ANALYSIS OF RIM AND RING REINFORCED OPENINGS IN PRESSURE VESSELS. R. Kitching (Manchester Coll. of Science and Tech., Eng.) and J. Perkins. Nucl. Eng., 8: 192-4(June 1963).

A stress analysis is made of vessels where openings are reinforced by a combination of a ring and a rim. The results are compared with some experimental values, and it is shown that the modified Bijlaard method gives the best results. (D.L.C.)

25395 DEVICE FOR THE PREPARATION OF STRIP SAMPLES. Y. Grunditz (Uppsala Univ.) and W. Parker. Nucl. Instr. Methods, 22: 369-70(Apr. 1963). (In English)

An improved vacuum deposition apparatus was developed for the preparation of radioactive strip samples. The apparatus, constructed as a single unit, comprises a simple toy motor geared to an interchangeable shaft, around which the backing material is wrapped. The apparatus is passed into a vacuum chamber. (D.L.C.)

25396 EQUIPMENT USED IN THE PERFORMANCE OF EXPERIMENTS IN NUCLEAR REACTORS AT THE ARGONNE NATIONAL LABORATORY. E. S. Sowa, C. R. Breden, and L. W. Fromm, Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 15: 415-28(Apr. 1963). (TID-16932; UAC-6701)

Experimental development of in-pile equipment over the last ten years has resulted in the design of unique systems involving a variety of experiments. The experiments range from simple corrosion and fuel irradiation tests to complex irradiation environment studies and fast reactor fuel failure tests. A summary is given of the type of facilities designed at the Argonne National Laboratory for these experiments and of the purpose for which the design was intended. In addition, typical values for test parameters are included to acquaint the reader with the conditions encountered during a test. The intent of the summary is to demonstrate the span of engineering experiments possible in reactors. Consequently, the results of the tests are not described or discussed since these results have been published in other papers. Instead, attention is directed toward the nature of equipment which has been brought into existence. (auth)

25397 GAS TURBINES IN NUCLEAR POWER ENGINEERING. Josef Bečvář (School of Mechanical and Electrical Engineering, Pilsen, Czechoslovakia). Tech. Dig. (Prague), 4: No. 11, 3-7(Nov. 1962). (In English)

The use of gas turbines in nuclear power generation primarily requiring high-temperature reactors, that is, reactors with the highest possible outlet temperature of the coolant, is at present in its early stage of development since experimental reactors with gas outlet temperatures of 650 to 750°C or higher are so far only in the projection or construction stages. Some gas-turbine designs suitable for application in nuclear power generation are outlined. (auth)

25398 GAS SEPARATION WITH THE MOLECULAR PUMP. I. SEPARATION FACTOR AND SEPARATION POTENTIAL OF A MOLECULAR PUMP WITH POSITION-INDEPENDENT SLIT HEIGHT. Otto Boettger and Hans Pingel (AEG-Forschungsinstitut, Frankfurt am Main). Z. Angew. Phys., 15: 320-5(Apr. 1963). (In German)

The separation factor and separation potential of a molecular pump with constant groove height were calculated for a two-component gas mixture. Knudsen streaming was assumed. Numerical values for the separation factor and separation potential for uranium hexafluoride are given. (tr-auth)

25399 NINTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION AT CORNELL UNIVERSITY, ITHACA, NEW YORK, AUGUST 27 TO SEPTEMBER 1, 1962. New York, Academic Press, 1963. 1113p.

One hundred eight papers were presented covering many areas in the combustion field. The main topics covered were laminar and turbulent gas flames, high temperature spectroscopy, reaction kinetics, hydrogen–oxygen reactions, detonation and transition to detonation, combustion instability, combustion involving solids, fundamental flame processes, chemical reactions and phase changes in supersonic flow, and reciprocating engine combustion research. Comments on nearly every paper were also included. (C.E.S.)

25400 METHOD OF WEIGHT DETERMINATION. Earl Randall Parker (to General Dynamics Corp.). U. S. Patent 3,083,298. Mar. 26, 1963. Filed Sept. 18, 1959.

An accurate method for measuring the weight of large masses of material such as oil, molten metals, rubber, water, and other liquids during processing is patented. A short-lived radioisotope is added to the material, whose weight is to be determined, and uniformly dispersed in the material. A sample is taken from the material and weighed, and the radioactivity of the sample is measured. From the known radioactivity of the radioisotope before introduction and the weight and radioactivity of the sample, the weight of the entire mass of material can be determined with a high degree of accuracy. Suitable corrections must be made for radioactive decay and self-shielding effects. The selection of suitable radioisotopes is discussed. The method is particularly applicable to steel-making processes, using the radioisotope Ni^{65}. (M.P.G.)

25401 DOOR SWINGING DEVICE WHICH MAKES IT POSSIBLE TO MOVE HEAVY DOORS WITH A REDUCED EFFORT. Raymond Haguet (to Commissariat a l'Energie Atomique). U. S. Patent 3,086,257. Apr. 23, 1963. Priority date May 6, 1958, France.

A device is patented which makes it possible to open and close doors weighing several tons by exerting a manual force of a few kilograms. A pressurized fluid such as oil is introduced between the members on which the door is suspended and rotated, thereby avoiding direct contact between the members and considerably reducing the friction. Details of the design are described, including using the fluid pressure to lock and unlock the door. (M.P.G.)

25402 DETECTION OF HEAT EXCHANGER LEAKS. Jay S. Curtice, Adolph I. Snow, and Lloyd A. Baillie (to Sinclair Research, Inc.). U. S. Patent 3,087,064. Apr. 23, 1963. Filed June 27, 1960.

A method for detecting and measuring leaks in process equipment such as feed-effluent heat exchangers is patented. A suitable radioactive-tracer compound is injected into the feed-stock, and a sample of the reaction-product effluent is taken after it has left the heat exchanger. The tracer must be one which is at least 90% chemically converted by the action of the reaction or reactors between the feed and effluent sides of the feed-effluent heat exchanger and at least 50% unconverted under heat-exchanger conditions. The converted tracer must be a tracer-labeled product, which can be separated from the unconverted tracer. If there is a leak in the feed-effluent heat exchanger, some of the tracer will bypass the reactor, and show up as unconverted tracer in the effluent product. The method is applicable to any process where a feed-effluent heat exchanger is used, such as reforming, catalytic or thermal cracking, or other refining or petrochemical processes. Suitable tracers for reforming systems are tritiated anisole and ethyl cyclohexane. (M.P.G.)

25403 REMOTE CONTROL ISOTOPE MANIPULATOR. Frank Schouten (to U. S. Army). U. S. Patent 3,087,632. Apr. 30, 1963. Filed Aug. 15, 1961.

A portable field device for lifting a high-intensity γ-radiation source from its shield without exposing the personnel involved is patented. The device raises the source inside a tube from its shield to a preselected position by air pressure supplied by an air compressor. The source remains suspended in a floating state in the tube until the air compressor is turned off, when the source will fall back into the shield. Details of the design are described and illustrated. (M.P.G.)

25404 BLEEDER VALVE OR PURGE VALVE. Emery J. Zahuranec (to Nuclear Products Co.). U. S. Patent 3,087,704. Apr. 30, 1963. Filed Nov. 23, 1959.

A purge or bleeder valve is patented that is simple, durable, and highly efficient. An end cap is joined by threads to the body of the valve, which can be connected to a fluid line by threads or any other means. A valving ball is interposed between the seat of the cap and the conical seat of the body. The ball is somewhat larger than the largest diameter of the body seat. This prevents dirt from collecting on the seat and also prevents the ball from sticking. The ball is

sealed against the seat by tightening the end cap. To open the valve, the end cap is unscrewed until a spring in the body of the valve forces the ball away from the conical seat. A relief port is formed in the cap wall and communicates with the bore of the valve. A notch in the end cap adjacent to the relief port enables the operator to locate the relief port by a sense of touch. (M.P.G.)

25405 THERMOCOMPENSATING JOINT. Harry Chilton (to United Kingdom Atomic Energy Authority). U. S. Patent 3,088,758. May 7, 1963. Priority date Feb. 12, 1958, Great Britain.

A joint between lengths of pipe is patented, which minimizes the tendency for the joined surfaces to separate due to differences in the thermal expansion coefficients of the pipes. A flange and means of clamping are designed so that the clamping pressure is applied in the contact plane of the surfaces to be joined. Various flanges and clamps to accomplish this are described and illustrated. (M.P.G.)

Heat Transfer and Fluid Flow

Refer also to abstract 26771.

25406 (AEEW-R-167) BURN-OUT ANALYSIS. PART 2. THE BASIC BURN-OUT CURVE. R. V. Macbeth (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Jan. 1963. 37p.

Examination of burnout data has revealed an important linear relationship between burnout heat flux and inlet subcooling to a channel. The observation has opened up a method of presenting the burnout phenomenon in a new form, called the basic burnout curve, which avoids the obscuration normally present due to other phenomena taking place simultaneously with burnout. Examination of the basic burnout curve shows that two distinct burnout regimes exist, characterized by the mass velocity in a channel, and many important features of these regimes are identified. As an aid to the analysis, burnout correlations are developed for round and rectangular channels, respectively, which give greater accuracy than any correlation hitherto. It is shown that these correlations also give, for the first time, confirmation of the Bell effect on burnout. (auth)

25407 (AERE-R-4022) FLOODING AND ASSOCIATED PHENOMENA IN FALLING FILM FLOW IN A TUBE. G. F. Hewitt and G. B. Wallis (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell Berks, England). May 1963. 26p.

A falling water film was set up in a vertical 1.25-in.-bore acrylic resin tube using porous sections for introducing and extracting the liquid. Air was passed upwards through the tube, countercurrent to the liquid flow, and the air flow rate required to carry liquid up beyond the injector (the "flooding point") was determined. An empirical relation for flooding rate was obtained. Measurements were made of liquid film thickness, pressure gradient, and interfacial profile for air flows from zero up to the flooding point. High-speed ciné films using a special lighting technique gave qualitative information on the flow structure and were analyzed for surface wave velocity. In relating these measured parameters and the flooding phenomena it became obvious that flooding did not occur as a result of reversal of flow under surface shear. It was more likely to be associated with the coarsening of the liquid surface waves leading to the build-up of liquid at the injector and consequent splashing upwards of the liquid. (auth)

25408 (CEA-2196) TRANSFERT DE CHALEUR PAR MELANGE DE LIQUIDE ET DE GAZ EN CONVECTION FORCEE TURBULENTE AVEC FAIBLE VAPORISATION DE LA PHASE LIQUIDE. (Heat Transfer by Gas-Liquid Mixture in Forced Turbulent Flow with Weak Vaporization of the Liquid Phase). J. Huyghe and H. Mondin (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucleaires, Grenoble). 1962. 83p.

Measurements were made of heat transfer and pressure drop in two-phase liquid flow. The stream was of the annular dispersed type, obtained by introducing a small quantity of liquid in a gas turbulent flow. The heat transfer experiments were performed without vaporization of the liquid phase. A notable improvement of the heat transfer coefficient of such a stream was observed, compared with a gas-alone or liquid-alone flow. The improvement concerning the gas-alone was of about 20 when compared with the same gas Reynolds number, of about 8 when it is compared with the same total mass flow rate. A hydrodynamic study of the flow pattern demonstrates the original structure of the flow, and allows the experimental results to be predicted by means of a simplified theory. (P.C.H.)

25409 (GEAP-4228) TRANSITION BOILING HEAT TRANSFER PROGRAM. Quarterly Progress Report No. 1, February–March 1963. Frank E. Tippets (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 15, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 11p. (EURAEC-640)

The objectives, scope, organization, and development progress made of a program for measuring and studying transition boiling in high-pressure bulk boiling water flows, with particular emphasis in the higher range of steam qualities, are summarized. (N.W.R.)

25410 (NAA-SR-7875) DYNAMIC VOID FRACTION MEASUREMENT SYSTEM. J. H. Kendron, E. E. Stoner, and G. M. Taylor (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 15, 1963. Contract AT(11-1)-Gen-8. 49p.

Various methods and techniques of measuring void fraction in boiling heat transfer media are discussed. Details of 17 void-fraction measurement systems are abstracted. A dynamic void-fraction measurement system is described, capable of continuously measuring void fraction at any position along a 12-ft test section. Void fraction (the ratio of vapor volume to total volume of a 2-phase mixture) is measured in boiling organic coolant contained by a test section of $\frac{5}{8}$-in.-OD nickel tube with 0.049-in. wall thickness. Measurement of void fraction without physical contact with the test section is achieved through the use of a radiation attenuation method. The intensity of a narrow 100-kev x-ray beam transmitted through the test section is measured and recorded to permit calculation of void fraction. An x-ray tube and scintillation detectors are mounted on a remotely controlled elevator assembly used for horizontal and vertical positioning. Major sources of measurement error due to fluctuations in x-ray tube output and fluctuation of detector power supply voltage are cancelled by using two detectors connected in a differential circuit. Detector cooling and heavy magnetic shielding further reduce measurement errors. Typical measurement accuracies for small and large void fractions are 0.05 ± 0.015 and 1.00 ± 0.022. (auth)

25411 (ORNL-3439) HEAT TRANSFER FROM SPENT REACTOR FUELS DURING SHIPPING: A PROPOSED METHOD FOR PREDICTING TEMPERATURE DISTRIBUTION IN FUEL BUNDLES AND COMPARISON WITH EXPERIMENTAL DATA. J. S. Watson (Oak Ridge National Lab., Tenn.). June 11, 1963. Contract W-7405-eng-26. 69p.

A simple method is developed for calculating or predicting temperature distributions in spent reactor fuels in shipping casks. The method accounts for radiant heat transfer between all the individual pins in a square array. With the dimensions of the fuel bundle, the configuration factors for radiation between various tubes in the bundle can be obtained from the tabulated numerical calculations presented. The configuration factors, along with the heat generation rates, surface emissivity, and the temperature of the wall of the cask can be used to estimate the temperature distribution automatically with the computer code presented or possibly by hand calculations by the method outlined. Experimental measurements of temperature distribution in electrically heated tube arrays in steel shells that simulated shipping casks were made to test the proposed calculational procedure. Several heat generation rates and bundles containing up to 64 tubes were tested in 12-in.- and 6-in.-inner diameter shells. Tests were made with the casks in horizontal and vertical positions. The predicted temperatures were very near those observed experimentally under the conditions in which heat transfer is likely to be a problem in fuel shipment, that is, when the temperatures are near or above 200°C and the casks do not contain large empty spaces. These are the conditions where radiation should be expected to be the most important mechanism. The calculational method may also be adapted to nonsquare arrays. (auth)

25412 (RT/ING(63)1) MODELLI ANALOGICI A CELLE PER SISTEMI CON FLUIDI IN MOTO. (Analog Model Elements for Systems Containing Fluid Flow). A. Mathis and P. Giordano (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio Ingegneria e Servomeccanismi Reattori, Ispra). Jan. 1963. 53p.

Finite-difference analog models, built with normal computer elements, were studied with regard to the simulation of distributed systems containing flowing fluids (cores of heterogeneous nuclear reactors, boilers, and heat exchangers in general). For nuclear reactors and boilers universal diagrams are given which show the amplitude and phase errors in the model response, as a function of the physical and thermal features of the system to be simulated (synthetized by suitable dimensional parameters), the maximum working frequency, and the number of cells of the model. In this way it is easy to find, for each practical case, the optimum of cells, with regard to the frequency range of interest, and to the permissible errors. (auth)

25413 (SAN-1007) TRANSIENT BOILING HEAT TRANSFER AND VOID VOLUME PRODUCTION IN CHANNEL FLOW. Reactor Heat Transients Research 1962 Annual Report. H. A. Johnson, V. E. Schrock, S. Fabic, and F. B. Selph (California. Univ., Berkeley. Inst. of Engineering Research). Mar. 1963. Contract AT(11-1)-34. 303p.

The development of test equipment, procedures, and data production for measurement of transient void growth in channel flow was continued. It was realized that the most difficult problem would be the development of suitable means for measuring transient void formation at growth rates in the millisecond range of time. Of various possibilities, the two methods selected for development were a visual (photographic) technique and an x-ray (absorption) densitometer. The measurement range of void volume per unit of surface area is, at present, for the visual technique at low pressure equal to 2.5×10^{-5} to 7 mm^3/mm^2 and at high pressure equal to 0.012 to 7 mm^3/mm^2 and for the x-ray densitometer equal to 0.1 to 7 mm^3/mm^2. The x-ray densitometer data are corrected for variation in liquid density so that the void volumes reported, for both methods, represent displaced liquid values. These ranges of values were compared with the following information on actual reactors. Zivi reported that a 0.001 mm displacement of the moderator over the fuel plates in the Spert III reactor could compensate $0.09 of reactivity during a power excursion having an initial period of 10 milliseconds. This amount of reactivity was found to be about one half of the total required to terminate the power burst. Thus it appears that for a pressurized water reactor, like Spert III, the resolution of the visual and x-ray techniques may be too large by factors of 10 and 100 respectively. If, however, the prediction of incipient nucleation and the effects of controlling parameters on void growth can be satisfactorily established then extrapolation methods can be developed to include the initial void volume growth region needed for pressurized water reactors. On the other hand, the range of measured values compares favorably with the void volume present in boiling water reactors. The test system geometry selected was that of an electrically heated ribbon mounted in the center of a flow channel. A capsule experiment was developed to determine if there is a high-energy radiation effect on boiling nucleation and bubble growth. Several analytical model studies were continued. Parametric effects on change of void volume were studied. (auth)

25414 (TID-18072) SODIUM HEATED STEAM GENERATOR SUMMARY. (Atomic Power Development Associates, Inc., Detroit). Sept. 19, 1962. Contract AT(11-1)-865. 74p.

A review of experimental and plant size steam generators used in all unclassified sodium-cooled reactors is presented in order that current data and information concerning the steam generators may be evaluated. Information is included on related equipment. Design and performance characteristics are given. (N.W.R.)

25415 (TID-18706) BASIC EXPERIMENTAL STUDIES OF BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES. Monthly Progress Report, April 1963. Bruce Matzner (Columbia Univ., New York. Engineering Research Labs.). Apr. 30, 1963. Contract AT(30-3)-187. 13p. (MPR-XIII-4-63)

During April, (47) instrumented burnout points and 1 intentional physical burnout were obtained for vertical upflow of water at 1000 psia inside a 1.475-in. ID heater tube. This tube simulates the inner channel of one of the candidate oxide fuel elements whose overall burnout performance was determined previously using the Composite Tubular Test Section. Analysis of the data showed that the burnout performance of the tube, when operated in parallel with the annular channel of the Composite Tubular Test Section, was lower than for separate, non-parallel operation. These results demonstrate the necessity of conducting burnout tests on whole fuel element geometries rather than component channels. Burnout testing of a 0.930-in. ID heater tube and fabrication of a 0.504-in. ID are now in progress. Fabrication of components directed toward upgrading loop capabilities is proceeding. (auth)

25416 (TID-18717) PRESSURE DROPS THROUGH CYLINDRICAL BEDS OF PACKED SPHERES. Final Report. W. F. Touchton, Jr. (Franklin Inst. Labs. for Re-

search and Development, Philadelphia). Feb. 1963. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract 2225. 134p. (F-B1994)

The procedures and data obtained in testing the effect of Reynolds number on the friction factor across a cylindrical bed of ¾, 1, 1¼, and 1½ inch diameter randomly packed spheres are included. The test results indicated the friction factors to be between 5.15 and 7.35 depending upon the ball size and surface finish. The Reynolds number was varied over a wide range, from a low of 3000 for the ¾ inch spheres to a maximum of 370,000 for the 1½ inch spheres. For all sizes, the friction factor became constant for Reynolds numbers above 40,000. The tests were run in the high pressure gas facility using carbon dioxide as the test fluid. (auth)

25417 DETERMINATION OF THE RATIO BETWEEN THE TURBULENT HEAT TRANSFER COEFFICIENTS AND THE MOMENTUM. V. I. Subbotin, M. Kh. Ibragimov, and E. V. Nomofilov. At. Energ. (USSR), 14: 414-16(Apr. 1963). (In Russian)

Heat transfer under turbulent conditions in liquid metals was studied at Prandtl number = 0.025 varying the Reynolds number from 20,000 to 450,000. The design of the apparatus was discussed in a previous publication (Atomnaya Energ., 11: 133(1961) No. 2). The final data were obtained by means of the graphic differentiation of the time-averaged data on the temperature distribution in turbulently flowing mercury stream. The maximum heat transfer coefficients ϵ_a with respect to the radius a of the pipe in the Re number region of 2×10^4 to 4.5×10^5 could be expressed approximately by the equation $(\epsilon_a/a)_{max} = 7.5 \times 10^{-5}$ Re. In the calculations Prandtl's and Reichardt's formulas on the velocity distribution in a turbulently flowing liquid were used; the latter is considered to be more reliable. The inequality coefficient correlating the turbulent heat transfer and the momentum contain factors, one of which is independent from the flow velocity of the liquid metal at $Re > 2 \times 10^4$, while the other depends only on the Re number. Formulas were derived for determining this factor. The value of ϵ plays an important role in the semiempirical heat transfer theory and its experimental determination confirms the correctness of the theory. A more fundamental theory still must be developed for the deeper understanding of the factors influencing the turbulent heat transfer phenomena. (TTT)

25418 STEADY STATE HEAT CONDUCTION IN CYLINDERS WITH MULTIPLE CONTINUOUS LINE HEAT SOURCES. B. A. Peavy. J. Res. Natl. Bur. Std., 67C: 119-27(Apr.-June 1963).

A mathematical analysis is presented for steady-state heat conduction in cylinders, consisting of one or two isotropic materials disposed in concentric cylindrical volumes around the axis, heated by one or more continuous line heat sources parallel to the axis. The analysis considers both cylinders of infinite length, and cylinders of finite length subject to longitudinal heat flows arising from end conditions. Numerical solutions are given considering the line sources to be equal in magnitude and equally spaced angularly at a uniform radius from the axis. An outgrowth of this analysis is the consideration of several new methods for the determination of the thermal properties of materials. (auth)

25419 THE EFFECT OF INLET SPACING DEVIATIONS ON THE FLOW-INDUCED DEFLECTIONS OF FLAT PLATES. J. J. Kane (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 15: 305-8(Mar. 1963).

An array of parallel flat plates is considered in which there are inlet deviations in the spacing. Analytic predictions are made of the effect of these deviations on the flow-induced deflections of the plates. It is shown that in the vicinity of Miller's critical velocity, small deviations are sufficient to cause large deflections. Lesser deflections are predicted for lower flow rates. (auth)

25420 STREAM FLOW MEASUREMENT BY AN INERT TRACER PULSE TECHNIQUE. R. P. Gardner and J. W. Dunn, III (Oak Ridge Inst. of Nuclear Studies, Tenn.). Nucl. Sci. Eng., 15: 338-41(Mar. 1963).

A technique is described and demonstrated for the determination of volumetric flow rates in open streams which consists of introducing an inert tracer concentration as an undefined pulse, sampling the concentration at a point downstream, and analyzing the samples by activation analysis. This method does not involve the introduction of any radioactive material into the stream and yet still retains most of the high sensitivity and selectivity of radiotracer techniques. (auth)

25421 EFFECTS OF BOUNDARY LAYER TURBULENCE PROMOTERS ON THE LOCAL FILM COEFFICIENTS OF ML-1 FUEL ELEMENTS. N. Kattchee and W. V. Mackewicz (Aerojet-General Nucleonics, San Ramon, Calif.). Nucl. Sci. Eng., 16: 31-8(May 1963).

Local convective heat transfer coefficients for a surface with integral boundary-layer turbulence promoters were determined by conducting naphthalene-to-air mass transfer tests and invoking the heat transfer–mass transfer analogy. The turbulence promoters were machined into the convex surface of an annulus. The experimental results were normalized relative to mass transfer coefficients on a smooth surface with parallel flow. On the faces of the turbulence promoters local heat transfer coefficients up to six times the smooth surface value were encountered. High transfer coefficients were found on the upstream and top faces. Coefficient values on the downstream surfaces were low and independent of geometry. Corner areas showed heat transfer coefficients lower than those for a smooth surface with parallel flow. The data from surfaces between two turbulence promoters were correlated in terms of a dimensionless location index. A broad heat transfer coefficient peak of 2.4 times the smooth surface magnitude was found 4 turbulence promoter heights downstream from a promoter. Each test also showed a narrow coefficient peak at the point about 0.5 height preceding a turbulence promoter. When correlated in this manner, the results revealed a unique generalized distribution of the transfer coefficient for surfaces with boundary layer turbulence promoters of rectangular cross section. The upstream and downstream regions of boundary layer separation were independent of the dimensions of the turbulence promoters. The estimated error for this series of tests was approximately ±20% of the maximum relative transfer coefficient values. (auth)

25422 ERRORS AND STABILITY OF THE ENTRY PROBLEM EQUATIONS IN LAMINAR MAGNETOHYDRODYNAMIC FLOW. J. L. Shohet (Johns Hopkins Univ., Baltimore). Phys. Fluids, 6: 797-802(June 1963).

The finite difference equations utilized to solve the entry problem in laminar magnetohydrodynamic flow are analyzed according to the Lax stability theory to determine the restrictions on velocity and mesh sizes required to permit a stable and convergent system when it is utilized on a computation device. (auth)

25423 REFLECTION AND REFRACTION OF MAGNET MAGNETO-ACOUSTIC WAVES AT AN INTERFACE. D. C. Pridmore-Brown (Aerospace Corp., Los Angeles). Phys. Fluids, 6: 803-5(June 1963).

The reflection and refraction of plane magnetohydrodynamic waves at an interface separating two different media are studied for various orientations of the external magnetic field. It is pointed out that by making use of trace velocity plots it is a simple matter to determine the nature and disposition of the reflected and refracted waves that are generated by an incident wave of any given species. (auth)

Materials Testing

25424 (TID-18710) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. (1) CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE VESSELS. (2) EFFECTS OF NOTCHES AND WELD DEFECTS ON PRESSURE VESSEL FATIGUE STRENGTH. A. G. Pickett and J. D. Michie (Southwest Research Inst., San Antonio). Mar. 31, 1963. Contract AT(11-1)-1228. 37p.

The plastic fatigue strength of 36-in. ID pressure vessels is investigated. The pressure vessels are fabricated from A-201, A-302, and T-1 steels and have a wall thickness of 2 in. Variables investigated are material properties, design details, fabrication methods, and inspection techniques. The fatigue strength of weld-repaired fatigue cracks is evaluated. Stress concentration factors determined in the static stress analysis, effects of strain redistribution upon initial cycling, and results of plastic fatigue tests are correlated. The effects of notches, flaws, and weld defects on plastic fatigue strength of pressure vessels are also correlated. (N.W.R.)

25425 (WADD-TR-61-91(Pt.III)) ULTRASONIC METHODS FOR NONDESTRUCTIVE EVALUATION OF CERAMIC COATINGS. A. M. Baumanis and W. E. Lawrie (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 28, 1963. Contract AF33(657)-8938. 41p.

Investigations into techniques to determine the strength and integrity of ceramic-metal bonds are described. Primary emphasis was placed on techniques for examining diffusion coatings although work continued on flame-sprayed coatings. Extensive investigations of Rayleigh wave techniques were made with promising results. Further work was done using the Schlieren optical method, and thermal effects were investigated in relation to Schlieren results. Investigations of an interferometric method for measurements of elastic constants have shown the method to have low accuracy. Neither destructive nor nondestructive methods were found to successfully measure bond strength of diffusion coatings. Preliminary investigations were made of thermal, electrical, and nuclear methods for examining flame-sprayed coatings. (auth)

25426 NEUTRON RADIOGRAPHIC INSPECTION OF RADIOACTIVE IRRADIATED REACTOR FUEL SPECIMENS. Harold Berger and W. N. Beck (Argonne National Lab., Ill.). Nucl. Sci. Eng., 15: 411-14(Apr. 1963). (ANL-F6F-391)

A method for nondestructive inspection of highly radioactive, irradiated reactor fuel specimens is described. The method is a neutron radiographic technique which employs image detectors of metal screens of silver, dysprosium, and indium. After exposing these screens to the neutron image, an autoradiograph of the metal screen is taken to produce the radiographic image. By using this technique, interference on the radiograph caused by the radioactivity of the test objects is eliminated. The image quality yielded by this method is excellent and easily shows fuel deformation and void areas, and other components within the fuel assembly capsule. The advantages of this method over other inspection methods for such materials are described. (auth)

25427 METHOD AND APPARATUS FOR RADIOGRAPHIC INSPECTION. Kiryako Arvanetakis and Byron A. Donzis (to Travel-Ray Corp.). U. S. Patent 3,087,058. Apr. 23, 1963. Filed Sept. 15, 1965.

A new and improved method and apparatus for radiographic inspection of welds in pipes, tanks, or other objects are patented. The apparatus includes a means for moving the radiographic unit relative to the weld, a means for moving the radiographic film and coordinating it with the movement of the radiographic unit, a means for stopping the longitudinal movement of the apparatus when a weld is reached, and a track for guiding the unit along a weld. The radiographic unit has a small focal area of emitted rays, and the rays are restricted so that only a beam of substantially parallel rays reaches the film. The designs of the apparatus to move the radiographic unit and to hold and move the film are described in detail. (M.P.G.)

25428 REFERENCE GAGE FOR RADIOGRAPHIC EXAMINATION OF TUBING. Martin B. Graham. U. S. Patent 3,088,027. Apr. 30, 1963. Filed Sept. 21, 1959.

A method of nondestructively testing boiler tubes or other boiler parts for internal pitting is patented. Flat bars or a section of unused boiler tube of the same material and thickness as the boiler tubes to be inspected are used as a reference gage. The bars or tube contain flat-bottom holes of graduated depths, and the gage is supported in any convenient manner adjacent to the boiler tube to be inspected. The boiler tube and gage are then inspected radiographically using a portable x-ray machine or a radioactive material. The film is inspected for the darkest spots, which are the images of the deepest pits in the boiler tube. The density of the spots is measured with a densitometer and compared with the densities of the hole images in the gage. In this way the depth of the pits can be approximated. It was determined experimentally that mineral matter deposited in the pits did not interfere with the radiographic inspection. (M.P.G.)

25429 METHOD AND APPARATUS FOR TESTING STRUCTURE OF MATERIALS BY MEANS OF ROENTGEN, GAMMA OR CORPUSCULAR RAYS. Friedrich Endter, (to Deutsche Gold- und Silver-Scheideanstalt). U. S. Patent 3,089,031. May 7, 1963. Priority date Dec. 22, 1956, Germany.

A method of continuously following structural changes in materials is patented. A beam of x rays, γ rays, or particles is directed against the material to be tested. A film or other material sensitive to the scattered rays is moved continuously across the field of the scattered rays at a sufficiently slow speed to produce a clear record. This method for testing materials and the apparatus used are described in detail. The method is especially valuable for studying changes as a function of temperature or to study the effects of heat treating in various atmospheres. (M.P.G.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

Refer also to abstracts 24765, 24777, 24778, 24779, 24780, 24781, 24782, 24783, 25534, and 26276.

25430 (NP-12807) METEORITE CLASSES AND RADIATION AGES. Peter Eberhardt and Johannes Geiss (Bern. Universität. Physikalisches Institut). 1963. 31p.

Radiation ages of the two UREY-CRAIG groups of chondrites show different distributions. In the high iron group the frequency is rapidly falling off toward higher ages, the low iron group shows an additional peak for ages around 25 m.y. This indicates a sizable collision at this time. A large amount of low iron group material was necessarily involved in this collision, corresponding to a body with a minimum diameter of 5 km. Also a difference is indicated between the potassium-argon age distributions of the two chondritic classes. The radiation age pattern of the aubrites is different from that of the chondrites. The aubrites were either not produced during the last 50 m.y. and thus were much more abundant before, or they differ in their orbits and spatial origin from the chondrites. (auth)

25431 (RISÖ-39) METEOROLOGICAL MEASUREMENTS AT RISÖ, 1958–1961. K. Jensen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1962. 88p.

Measurements of wind, temperature, and precipitation made from the meteorological tower at Risø are reported. Means, variations, and frequencies are presented in graphic form, as well as profiles of the air layer from the surface to 123 m regarding wind velocity and temperature. Means, variations, frequencies, and distributions are given of the parameters contained in the statistical diffusion formula introduced by O. G. Sutton. The variation and frequency of stability and smoke-trail classifications are discussed. A detailed graphic presentation is made of rapid temperature changes, inversions, and special weather conditions within the period. The vertical variation of the diffusion parameter C_y is given. A determination of the roughness length at the meteorological station at Risø is made. (auth)

25432 (TID-18690) DETERMINATION OF POROSITY FROM DENSITY LOGS IN ALLUVIUM, NEVADA TEST SITE. Technical Letter: NTS-51. R. D. Carroll (Geological Survey, Denver). May 6, 1963. 4p.

The determination of porosity from density logs obtained in holes drilled with mud in the alluvium at Nevada Test Site can be made by the following equation: $Db = Dg(1 - \Theta) + Df(\Theta)$, where Db is saturated bulk density, Dg is grain density, Df is density of saturating fluid, and Θ is fractional porosity. A chart is given for converting density log readings to porosity values. (M.C.G.)

25433 SYSTEMS OF EQUATIONS FROM THE THEORY OF SUCCESSIVE DISINTEGRATIONS. THEIR APPLICATION TO NATURAL RADIOACTIVITY OF THE ATMOSPHERE. Josef Thomas (Inst. for the Work Hygiene and Vocational Diseases, Prague). Apl. Mat., 8: 118-28(1963).

Relations that occur in studies of natural radioactivity in the atmosphere and are used for measuring radon daughter product concentrations or the influence of ventilation on the departure from the radioactive equilibrium are derived from the solution of a system of nonhomogenous linear differential equations with supplementary conditions. A number of generally valid identities are given that are suitable for operations with the given relations. (OTS)

25434 APPLICATIONS: THE RADIOACTIVITY OF WATER. D. Biettmann and M. Thénard. Bull. Inform. Sci. Tech. (Paris), No. 67, 51-7(Dec. 1962). (In French)

For the preparation of low-level standards, water of very low radioactivity is necessary. The three apparatuses constructed to measure the activity of mineral waters are described, and the determination of activities is discussed. The demineralization of Charrier mineral water (the water with the lowest natural radioactivity) is made in two steps, distillation and mixed-bed ion exchange. (J.S.R.)

25435 ON THE VARIATION IN RELATIVE ABUNDANCES OF RARE EARTH ELEMENTS AMONG METEORITES, IGNEOUS ROCKS AND SEDIMENTS. Yoshito Matsui and Akimasa Masuda (Tokyo Univ.). Geochim. Cosmochim. Acta, 27: 547-9(May 1963). (In English)

The validity of the formula, $\log (E_i/La) = i/7 \log (Gd/La) + c_i$ (where E_i denotes the i-th element from La in the periodic table, and c_i is an integral constant of E_i), was checked on selected data of rocks, inclusive of meteorites, and it was found that it can be tolerably applied to rocks also. A diagram of previously determined data suggests that crustal materials with stronger concentrations of lighter rare earths can be well derived from chondritic materials, probably, by the successive magmatic fractionation. Also in the diagram, sequence in the degree of enrichment towards lighter rare earths is parallel with that in the acidity of silicate material. (P.C.H.)

25436 THE EFFECTS OF ATMOSPHERIC NO_2 ON THE MEASURED ISOTOPIC COMPOSITION OF ATMOSPHERIC CO_2. Harmon Craig and Charles D. Keeling (Scripps Inst. of Oceanography, La Jolla, Calif.). Geochim. Cosmochim. Acta, 27: 549-51(May 1963). (In English)

The consequences of the effects of the slight concentration of N_2O in the atmosphere in the isotopic studies of CO_2 are discussed. N_2O has the same molecular masses as CO_2 (44, 45, 46), and being isoteric with CO_2, has almost exactly the same physical properties, including vapor pressure. Thus N_2O is condensed in liquid N_2 during removal of CO_2 from air, follows the CO_2 through purification by fractional distillation, and enters the mass spectrometer as a contaminant with identical mass numbers but quite a different isotope ratio. Indicated corrections to be added to the measured isotopic delta values of atmospheric CO_2 were determined to be +0.6‰ for C^{13} and +0.8‰ for O^{18}. (P.C.H.)

25437 EXPERIMENTAL USE OF THE BIOGEOCHEMICAL METHOD IN URANIUM SEARCHES IN CONDITIONS OF THE DESERT. M. M. Botova, D. P. Malyuga, and U. I. Moiseenko (Ministry of Geology and Conservation of Mineral Resources, USSR and Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 4, 361-9(Apr. 1963). (In Russian)

Data are given on the effectiveness of the biogeochemical method in searches for U under desert conditions. A high activity of the local xerophytic vegetation in U accumulation was noted. The U content in Astragalus villosisimus and others, reaches 8.0×10^{-3}% in ash and correlates distinctly with the localization of the ore deposit. The method may be recommended in searches for U in zones of arid climate. (auth)

25438 AROMATIC MONOMERS OF LIGNIN IN LIGNITES, THEIR POSSIBLE ROLE IN THE CONCENTRA-

TION OF URANIUM, GERMANIUM, VANADIUM. S. M. Manskaya and L. A. Kodina (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 4, 370-82(Apr. 1963). (In Russian)

The alteration character of lignin of fossil wood is considered in connection with the problem on the concentration of metals in the organic matter of lignites; samples of wood buried in peat deposits and lignites of tertiary age were studied. With the aid of the methods of ethanolysis, paper chromatography, and uv spectrophotometry, vaniloylmethylketone and vanillin were quantitatively determined in wood of a different degree of destruction, in lignites and humic acids from these materials. It was found that lignin undergoes deep alteration in the buried wood during a geological period of time. The process is accompanied by a partial destruction of polymeric lignin structure with a liberation of phenylpropane monomers. The latter may participate in reactions of the formation of humic acids of lignites and may be the basis for condensated structures appearing in consequence of the formation of additional bonds between carbon atoms of propane chains. It is suggested that the accumulation of U, Ge, and V in lignites occurred most intensively in the early stage of wood destruction in the interaction of the metals with groups of aromatic lignin structures being capable of reaction. (auth)

25439 COMPUTER ANALYSIS OF GAMMA-RAY LOGS. J. H. Scott (Geological Survey, Denver). Geophysics, 28: 457-65(June 1963).

A computer program recently developed determines U_3O_8 grades for hypothetical half-foot thick layers that are assumed to comprise a uranium ore zone represented by a gamma-ray log anomaly. First approximations of the grades of the half-foot layers are made proportional to the gamma-ray log deflections corrected for instrument dead time. The grades of the hypothetical half-foot layers are then adjusted by an iterative process until a synthetic anomaly calculated from them converges with the real gamma-ray log anomaly. When a good fit is obtained, the U_3O_8 grades assigned to the hypothetical layers at that time are taken as the correct values. Advantages of the computer method over conventional hand methods include greater speed, lower cost, and more useful results. (auth)

25440 GEOPHYSICAL RESEARCH AND PROGRESS IN EXPLORATION. F. A. Van Melle, D. L. Faass, S. Kaufman, G. W. Postma, and A. J. Seriff (Shell Development Co., Houston, Tex.). Geophysics, 28: 466-78(June 1963).

The most salient trend in geophysical exploration was one toward full utilization of the available data. Modern data-processing equipment and techniques of analysis are being introduced while theoretical studies, many growing out of communication theory, attack seismic stumbling blocks such as multiple reflections, ghosts, diffractions, and other unwanted events. The vistas of innovation opened by digital recording and processing have spurred several operators to intensive study of the possibilities and the cost of digital methods. The use of seismic energy sources other than conventional dynamite explosions is increasing, as are special shooting techniques aimed at ghost elimination. Synthetic seismograms from continuous velocity logs are being brought to bear increasingly on stratigraphic problems; inverse convolution techniques seek to reconstruct the CVL from better quality seismograms, and research on synthetic seismograms continues at a high level. Applications of the rubidium vapor magnetometer were reported both in exploration for minerals and in exploration for oil. The accuracy of the airborne gravimeter has been improved but is still insufficient for exploration purposes. The shipborne companion instrument is in use as an exploration tool. Existing well logging methods have undergone further development, and modern methods of electronic data processing are being applied increasingly. A new logging technique, nuclear magnetism logging, promises to give an indication of porosity above a certain pore size. A new interest has developed in natural electromagnetic fields and in the degree of coherence between electric and magnetic field components. Several of the projects created to achieve adequate detection of underground nuclear blasts, have exploration potential. Academic research in all branches of geophysics is quite active, with major benefits deriving from modern data handling techniques and from the new defense interest in the earth sciences. (auth)

25441 THE MAIN PHASE OF GREAT MAGNETIC STORMS. S.-I. Akasofu (Univ. of Alaska, College), S. Chapman, and D. Venkatesan. J. Geophys. Res., 68: 3345-50 (June 1, 1963).

It is shown that the main phase of great magnetic storms is composed of two parts, most clearly characterized by their decay rate: one decays much more rapidly than the other. It is suggested that extraordinarily intense storms are largely a result of an abnormal growth of the rapidly decaying part. Because of its rapid decay, the combination with the slow decay part gives a rather sharp change of decay rate, which is commonly seen for great storms. The results are discussed in the light of theoretical knowledge. (auth)

25442 THE PREDICTION OF GEOMAGNETIC DISTURBANCE INDICES. 1. THE ELIMINATION OF INTERNALLY PREDICTABLE VARIATIONS. Norman J. McDonald and Fred Ward (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 68: 3351-73 (June 1, 1963).

Prediction equations for the magnetic character figure C_1 are developed by multiple-regression procedures for periods 1, 2, 7, and 27 days in advance. The equations use as predictors only past values of C_1 itself. The results indicate that the only consistently useful information for prediction is obtained from various combinations of properly weighted predictors 1, 2, 3, 26, 27, 28, 53, 54, and 55 days before the predicted day. The 1-day prediction equations, when applied to a recent set of C_1 data (1950 to 1959), remove all the linearly internally predictable components. The spectrum of the time series remaining after the predictable information is removed closely resembles white noise. This filtered time series is well suited for pilot studies designed to determine the complex underlying physical causes of geomagnetic disturbance. (auth)

25443 GEOMAGNETIC MICROPULSATIONS WITH PERIODS FROM 0.03 TO 10 SECONDS IN THE AURORAL ZONES WITH SPECIAL REFERENCE TO CONJUGATE-POINT STUDIES. K. Yanagihara (Univ. of British Columbia, Vancouver). J. Geophys. Res., 68: 3383-97(June 1, 1963).

Conspicuous micropulsations in the auroral zones with periods from 0.03 to 10 seconds are studied using data obtained by the Pacific Naval Laboratory and Stanford University during January 1961. For periods less than 0.3 second bursts of oscillations frequently occur superimposed on the background level of ELF noise. These bursts are considered to be of extra-atmospheric origin because of their conjugate relationships. For periods between 0.3 and 10 seconds four typical classes are defined: burstlike micropulsations, with quite a wide range of frequencies, which appear at the onset of a polar storm or bay (noise

burst); pearl, beating-type micropulsations, occurring intermittently so that they form separate bunches (PP); continuous micropulsations, typically found in the forenoon, with periods from 0.3 to 3 seconds (CPsp); and continuous micropulsations, typically found in the afternoon, with periods from 3 to 10 seconds (CPlp). Not every polar storm or bay is accompanied by noise bursts. Noise bursts are found only at the onset of polar storms or bays occurring around or before local midnight. Separate bunches of pearl, beating-type micropulsations are attributed to a bouncing agent whose bouncing period of a few minutes can be determined from the time lag of their occurrences in conjugate areas. If the agent repeatedly excites micropulsations, they are continuous, although sometimes a correlation analysis between conjugate points indicates a bouncing period similar to that of PP. Possible physical mechanisms are suggested for these four classes of micropulsations. (auth)

25444 RELATIVE EXCITATION OF SURFACE WAVES BY EARTHQUAKES AND UNDERGROUND EXPLOSIONS IN THE CALIFORNIA-NEVADA REGION. James Brune, Alvaro Espinosa, and Jack Oliver (Columbia Univ., Palisades, N. Y.). J. Geophys. Res., 68: 3501-13(June 1, 1963).

The results of a study of the relative excitation of long-period and short-period seismic waves by earthquakes and explosions in the California-Nevada region are presented. The Richter magnitude M, which is based on the amplitudes of short-period waves recorded at sites less than 600 km from the epicenter, is used as a measure of short-period waves. A parameter AR—the sum of the areas of the envelopes of the surface waves on certain three-component long-period instruments—is defined and used as a measure of the long-period waves. The surface wave parameter is determined from long-period seismograph records from California, Nevada, and New York. The West Coast stations provide good azimuthal sampling of most of the events studied. Surface waves recorded at Palisades, from the Fallon-Stillwater and Fairview Peak-Dixie Valley aftershock sequences are also studied. There is a wide range in the excitation of surface waves for a given Richter magnitude, especially for earthquakes. For any given earthquake there may also be a wide range in the excitation of surface waves as a function of azimuth, an indication of an asymmetrical radiation pattern. Generally speaking, the relative excitation of surface waves by explosions is much smaller than by earthquakes of the same Richter magnitude. Most of the earthquakes studied generated surface waves 5 to 10 times greater than the maximum observed for explosions of the same Richter magnitude. A comparison of the relative excitation of surface waves in different regions indicates a very large regional variation. Shocks off the coast of northern California generate relatively large surface waves, whereas shocks near Laguna Salada in Baja, California, often generate very small surface waves. An empirical curve is derived for the variation of the surface wave parameter AR as a function of distance. A formula for estimating the surface wave magnitude is derived from AR. (auth)

25445 HEAVY ELEMENTS IN THE PANTAR METEORITE. George W. Reed (Argonne National Lab., Ill. and Univ. of Chicago). J. Geophys. Res., 68: 3531-5(June 1, 1963). (TID-18372; UAC-7175)

A determination of the elements Bi, U, Ba, Ag, and Pd in the Pantar meteorite is made. Bismuth appears enriched in the dark fraction (~8.8 ppb) relative to the light (~1.6 ppb) by a factor of about 5 to 6. This is consistent with rare-gas enrichment in the darker material and with the fact that Bi, Tl, and Pb and rare gases are considerably more abundant in some types of meteorites, the enstatite and carbonaceous chondrites, than in ordinary chondrites. Some of these elements are determined in two other meteorites, Ensisheim and Lancè. The concentration of Ag in Pantar and Ensisheim is about 33 ppb. Pd concentrations, 0.13 to 0.53 ppm, appear to vary according to the amounts of metal phase in these stones. Some variations in the Ba concentrations are noted. (auth)

25446 ISOTOPIC COMPOSITION OF STRONTIUM IN SOME AFRICAN CARBONATITES AND LIMESTONES AND IN STRONTIUM MINERALS. E. I. Hamilton (Oxford Univ.) and T. Deans. Nature, 198: 776-7(May 25, 1963).

The isotopic composition of strontium was measured in samples of African carbonatites, limestones, and strontium minerals from several localities. The isotopic composition of Sr in carbonatites differed from that of limestones. (C.H.)

25447 USE OF 'LOCAL MEAN AURORAL TIME' FOR VERY-LOW-FREQUENCY EMISSIONS. Neil Brice and Eigil Ungstrup (Sanford Univ., Calif.). Nature, 198: 874 (June 1, 1963).

The difference between local mean solar time and auroral time is a function of location, time of day, and season. Local mean auroral time is defined so that the difference between local (mean solar) time and local mean auroral time is constant. For any location on a meridian of auroral longitude, local mean auroral time is defined as equal to local mean solar time at the intersection of this meridian and the geographic equator. The seasonal variation of auroral time is thus eliminated by using the mean Sun position (for which the sub-solar point is always on the equator) and the diurnal variation by defining the duration of a mean auroral hour to be constant. Since the auroral pole is located at a high geographic latitude, a good approximation to the difference between mean auroral time and mean solar time is given by the angle between the direction of the auroral pole (along a great circle path) and the corresponding geographic pole (north or south), each 15 degrees representing 1 h. Although at the geographic pole local time is undefined, mean auroral noon occurs when this pole is directly between the auroral pole and the Sun, this being local (mean solar) midnight at the auroral pole. Use of local mean auroral time gives a consistent diurnal occurrence pattern for very-low-frequency emissions. Along the west coast of Greenland, emissions were recorded at a series of locations, all approximately on the same auroral meridian. None of the lower latitude types of emissions was heard and the time of peak occurrence of the low band appeared constant, regardless of latitude. At a series of locations in Antarctica, no such consistency was observed when the peak occurrence was measured in local time. However, the difference between the measured local time and that given by the Greenland data corresponded approximately at each location to the angle between the direction of the auroral pole and geographic south. Hence, if the occurrence is measured, not in local mean solar time, but in local mean auroral time, much better consistency is found among the Antarctic stations (including observations at the south geographic pole), and agreement with the Arctic results. Since the emission peak is a couple of hours wide, no great increase in error is introduced by using approximate mean auroral time rather than exact auroral time. The time of peak occurrence for emissions below 60° auroral latitude increases approximately linearly with latitude while the higher latitude low band peak is approximately independent of auroral latitude. The overall effect

is similar to a spiral caused by positive particle precipitation. Further measurements and refined analysis may determine whether there is a continuous variation in peak occurrence or whether the lower or higher latitude phenomena are essentially independent. (C.H.)

25448 INQUEST ON THE SPACE BOMB. THE TECHNICAL BACKGROUND AND THE POLITICAL PROSPECTS. Peter Stubbs. New Scientist, 18: 428-30(May 23, 1963).

The advantages and disadvantages of the effects produced by the high-altitude nuclear explosions are discussed. A brief summary of the information obtained from the explosions is presented. The political aspects of the secrecy surrounding the military information obtained from the experiments are also considered. (C.E.S.)

25449 EXPERIMENTAL TEST FOR THE DYNAMO THEORY OF EARTH AND STELLAR MAGNETISM. F. Winterberg (Case Inst. of Tech., Cleveland). Phys. Rev., 131: 29-37(July 1, 1963).

The dynamo theories to explain earth and stellar magnetism are confronted with great theoretical difficulties. For this reason it was not possible to reach a final conclusion on the feasibility of self-sustaining hydromagnetic dynamos. In order to solve these difficulties, it is suggested to test the dynamo theory experimentally under laboratory conditions. It is proposed to put a liquid conductor into a container of a rapidly rotating ultracentrifuge. To drive the dynamo, forceful fluid motions must be induced in the liquid conductor. This can be done either by externally applied forces, for instance by propellers, or by thermal convection. By assuming the validity of similarity laws it is possible to show that conditions presumably present in stellar-size dynamos can be simulated under laboratory conditions. (auth)

25450 THE ROLE OF DIFFUSIOPHORESIS IN THE SCAVENGING OF RADIOACTIVE PARTICLES FROM THE ATMOSPHERE. P. Goldsmith, H. J. Delafield, and L. C. Cox. Quart. J. Roy. Meteorol. Soc., 89: 43-61(Jan. 1963). (AERE-R-4097)

The absolute efficiency of diffusiophoresis in scavenging radioactive fallout particles from the atmosphere, because of cloud droplets growing by condensation, is low. This was confirmed by a cloud chamber experiment in which inactive salt droplets were grown in the atmosphere of a radioactive aerosol. The wash-out due to diffusiophoresis accounts for less than 1% of the total observed wash-out of nuclear bomb debris for each condensation cycle occurring in nature. Cloud droplets would have to undergo over 100 condensation-evaporation cycles on the same condensation nucleus for diffusiophoresis to be responsible for most of the observed wash-out. (Air Pollution Control Assoc., Vol. 9, No. 1, June 1963)

25451 ATMOSPHERIC CIRCULATION FROM FISSION-PRODUCT RADIOACTIVITY IN SURFACE AIR. D. O. Staley (Univ. of Arizona, Tucson). Science, 140: 667-70 (May 10, 1963).

The β activity of fission products in surface air is analyzed in a diagram, with latitude and time as coordinates. Spring-season maxima and spread of new debris are readily discerned. Debris from 1961 Soviet testing, traveling by way of the upper troposphere or the stratosphere, arrived at 16 to 35°S more than a month before debris transported through the troposphere. A maximum lateral-diffusion coefficient of about 4×10^5 m^2 sec^{-1} is implied for the tropical troposphere, and a much larger value in middle and high latitudes. Debris in the troposphere from United States testing at 2°N spread mostly into the southern hemisphere. (auth)

25452 CONCENTRATION OF TITANIUM–ZIRCONIUM SEA SANDS. A. A. Nikitin, V. S. Dokshin, F. I. Korneev, and V. O. Godass. Tsvetn. Metal., No. 2, 8-14(Feb. 1963). (In Russian)

Gravitational enrichment and magnetic separation of Ti–Zr sands of the tertiary period are described. The weight of the sand in the deposit is 1.9 to 2.15 t/m^3, moisture content is 5.6 to 12.3%, elmenite grain size is 0.25 to 0.07 mm, rutile grain size is 0.25 to 0.06 mm, and zirconia grain size is 0.15 to 0.06 mm. The design and performance of the concentration installation is described. (R.V.J.)

25453 STUDIES IN RADIOCARBON DATING. Hyman Schultz. Thesis, University Park, Penna., Pennsylvania State Univ., 1962. 85p.

The assignment of correct ages to samples submitted for radiocarbon dating depends on the elimination of noncontemporaneous carboniferous materials from the samples. From theoretical considerations, it was felt that the standard alkali pretreatment was not sufficient to remove all contamination. An attempt was made to extract cellulose from "cellulosic" samples such as wood and elementary carbon from "charred" samples such as charcoal in order to obtain correct dates. Cellulose was extracted from "cellulosic" samples by treating the samples to obtain crude fiber and extracting the cellulose from the crude fiber with Schweizer's reagent. Elementary carbon was obtained from "charred" samples by destroying all organic materials in boiling 70% HNO_3. Cellulose and carbon that were extracted were burned to CO_2 which was purified and converted to CH_4 over a ruthenium catalyst. After purification the CH_4 was counted in the proportional region. Samples were selected because their previous dating history indicated clearly the presence of contaminants. Cellulose or carbon was extracted and dated. The results conclusively indicated the inadequacy of the standard alkali pretreatment to deal with all types of contamination. The extraction of cellulose or carbon from "cellulosic" or charred samples was concluded to be the only sure way to obtain correct dates. (Dissertation Abstr. 23: May 1963)

25454 REDKIE ELEMENTY V MASSIVAKH SHCHELOCHNYKH POROD (Rare Elements in Alkali Rocks of Mountain Ranges). Moscow, Publishing House of the Academy of Sciences, 1962. 247p.

Twelve articles are included on crystallography, mineralogy, geochemistry, and rare-earth inclusions in rock of the Kola peninsula, Lovozerskii Mountain Range, and Cherry Mountain in the Urals. (R.V.J.)

25455 VOPROSY YADERNOI METEOROLOGII. (Problems of Nuclear Meteorology). I. L. Karolya and S. G. Malakhova. Moscow, Gosatomizdat, 1962. 273p.

Fifteen articles are compiled on nuclear meteorological problems investigated during 1960 to 1961. The articles are divided into three groups: the first group deals with large-scale propagations of natural radioactive isotopes in the troposphere and stratosphere and their applications in investigations of basic large-scale air-mass motion. Articles of the second group deal with radioactive aerosol capture by cloud drops and atmospheric precipitation and effects of radioactive aerosol elution by precipitation on the general radioactivity of the lower atmosphere. The third group of articles reports results of theoretical and experimental studies of turbulent-medium and small-scale aerosol diffusion into the troposphere. (R.V.J.)

25456 NUCLEAR GEOPHYSICS. Proceedings of a Conference, Woods Hole, Massachusetts, June 7-9, 1962. Nuclear Science Series Report Number 38. Washington, D. C., National Academy of Sciences–National Research Council, 1963. 253p. $2.75. (NAS-NRC-1075)

Important advances in the field of nuclear geophysics are presented. Topics discussed are the earth's interior, geochronology, oceanic mixing, uranium-series dating, stable isotope thermometry and content in Precambrian rocks, and meteorite phenomena. Separate abstracts were prepared for 13 of the 32 papers presented. One paper "Anomalous U^{234}/U^{235} Ratios in Nature" was previously abstracted in NSA-17: 5096. (C.E.S.)

25457 EFFECTS OF CONTACT METAMORPHISM ON Rb–Sr SYSTEMS. P. W. Gast and G. N. Hanson (Univ. of Minnesota, Minneapolis). p.25-33 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

The increasingly frequent occurrence of discordant Rb–Sr ages measured on the mineral biotite was investigated for possible mechanisms and physical conditions that may be responsible for the apparent loss of Sr^{87}. Simple contact metamorphism of a billion year old Duluth Gabbro and a 2.5 billion year old Snowbank granite is studied. It is assumed that the low Rb–Sr ages are due to removal of radiogenic Sr^{87} from the biotite during an interval of time when the country rock was heated by the gabbro. A model considering time and temperature as major variables is developed. (C.E.S.)

25458 THE RELATION BETWEEN RADIOACTIVITY AND DISCORDANCE IN ZIRCONS. L. T. Silver (California Inst. of Tech., Pasadena). p.34-42 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

Zircons extracted from Cambrian granites showed considerable variation in uranium content and total radioactivity. The more radioactive the zircon, the more discordant the Pb^{206}/U^{238} to Pb^{207}/U^{235} ratio and the apparent ages. It is shown that the Pb/U ratios and the implicit ages decrease as the concentration of uranium increases. (C.E.S.)

25459 DIFFUSION PHENOMENA IN GEOCHRONOLOGY. G. J. Wasserborg (California Inst. of Tech., Pasadena). p.52-5 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

A simple model is proposed to account for the types of discordance of radioactivity and uranium content in zircons extracted from Cambrian granites. The model is a simple lead loss diffusion model for a sphere and associated boundary conditions, assuming the uranium concentration to be uniform. (C.E.S.)

25460 EVIDENCE OF CONTINUING SEPARATION OF SIAL FROM THE MANTLE FROM THE ISOTOPIC COMPOSITION OF COMMON STRONTIUM. P. M. Hurley, G. Faure, H. Hughes, H. W. Fairbairn, and W. H. Pinson, Jr. (Massachusetts Inst. of Tech., Cambridge). p.82-92 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

In order to test the question of the time of principal Rb/Sr enrichment in the various age provinces of the continental basements, the results of whole-rock analyses on a variety of different types of sial are compared with the geologic age of the sial as found by standard methods of geochronology. An assumed value of 0.708 for the initial Sr^{87}/Sr^{86} ratio in the rocks is used as a preliminary measure. It is shown that there is a close correlation between the time of introduction of Rb into the sial and the geologic age. (C.E.S.)

25461 XENON IN TERRESTRIAL ROCKS. J. H. Reynolds (Univ. of California, Berkeley). p.93-9 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

Xenon isotopic contents are reported for Bavarian eclogite, representative of a deep-seated source, old granites from Central Transvaal, S. Africa, and a CO_2 gas sample from a New Mexico well. (C.E.S.)

25462 TRITIUM IN SURFACE WATERS OF THE NORTH PACIFIC. A. E. Bainbridge (Univ. of California, San Diego). p.129-37 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

Samples of surface ocean water in the North Pacific were collected and analyzed for tritium. The results show that although there was a strong north-south variation in specific activity, there was little in the east-west direction. A quantitative estimate of the residence time of water in the mixed layer and the depth of the mixed layer were estimated. (C.E.S.)

25463 NATURAL RADIOCARBON IN THE PACIFIC AND INDIAN OCEANS. G. S. Bien, N. W. Rakestraw, and H. E. Suess. p.152-60 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

Natural C^{14} distributions in deep and surface waters of the Indian and Pacific Oceans are presented. The application to absorption rates of CO_2 from the atmosphere, the rate and extent of ocean layer mixing, and the speed of deep water movement is discussed. (C.E.S.)

25464 C^{14}/C^{12} RATIOS IN SURFACE OCEAN WATER. Wallace S. Broecker (Lamont Geological Observatory, Palisades, N. Y.). p.138-49 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

The available data on the ratio of C^{14} to C^{12} in the inorganic carbon of surface ocean water as a function of geographic location and time are outlined. Their implications in connection with radiocarbon dating of fossil marine organisms, the rate of exchange of gases between the ocean and the atmosphere, and the rate of mixing between the warm surface and cold deep waters of the ocean are discussed. (C.E.S.)

25465 DIRECT COMPARISON OF RADIOCARBON AND FALLOUT MEASUREMENTS IN SEA WATER. Wallace S. Broecker and Gregory G. Rocco (Lamont Geological Observatory, Palisades, N. Y.). p.150-1 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

In an attempt to understand the anomaly of vertical mixing in the oceans, a set of carefully collected water samples from the Caribbean Sea was subjected to both C^{14} and Sr^{90}–Cs^{137} analyses. (C.E.S.)

25466 ABUNDANCES OF THE NOBLE GASES IN THE ATMOSPHERE AND IN METEORITES. H. E. Suess (Univ. of California, San Diego). p.161-6 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

Data are presented on the content of Ne, Ar, Kr, and Xe in the atmosphere and possibly in the interior of the earth. Depletion factors of noble gases on the earth relative to their solar abundance are presented. Noble gas content in meteorites is also discussed. (C.E.S.)

25467 HIGH-TEMPERATURE ISOTOPIC THERMOMETRY. Robert N. Clayton (Univ. of Chicago). p.185-95 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

Igneous, metamorphic, and hydrothermal rocks that preserve an equilibrium fractionation from the time of crystallization with derivations on the order of 0.1% or less provide a geological thermometer of wide range and rather high accuracy. The temperatures derived from isotopic measurements are judged on the basis of reasonableness in relation to existing geological thought about the rocks involved and compared with results of other geothermometric measurements. The O^{18}/O^{16} distribution is used. (C.E.S.)

25468 ISOTOPIC ABUNDANCES OF SOME ELEMENTS IN METEORITES. V. Rama Murthy (Univ. of California, San Diego). p.209-18 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

The stable isotope abundances of silver, molybdenum, samarium, europium, and gadolinium in meteorites are presented. (C.E.S.)

25469 RECENT C^{14} DATA FROM UPPER TROPOSPHERE. G. J. Fergusson (Univ. of California, Los Angeles). p.240-4 of "Nuclear Geophysics." Washington, D. C., National Academy of Sciences–National Research Council, 1963.

The C^{14} activity of the upper troposphere was investigated for information on atmospheric circulation and estimation of the amount of C^{14} introduced to the troposphere in a given time period. An estimate of CO_2 movement out of the troposphere and into the ocean and biosphere was also made. (C.E.S.)

25470 REMOTE RECORDING ANNULAR VANE ASSEMBLY. George Wehmann (to U. S. Atomic Energy Commission). U. S. Patent 3,094,869. June 25, 1963.

A weather vane apparatus is described which is capable of movement in horizontal and vertical planes. Associated with the vane are tangent potentiometers, commutators, and other electrical apparatus for deriving electrical output voltages as a function of the wind direction. The apparatus is particularly adapted for use with an anemometer to provide an electrical output indicating the amount and direction of an up or down draft. (AEC)

HEALTH AND SAFETY

Refer also to abstracts 24791, 24792, 24797, 25968, 26107, 26108, 26109, 26110, 26111, 26197,, 26216, 26217, 26220, 26225, 26227, 26777, and 26868.

25471 (AERE-R-4307) DECONTAMINATION AT HARWELL. H. J. Blythe (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1963. 19p.

The historical background, existing facilities, and decontamination practices at Harwell are outlined. Methods of contamination are also briefly mentioned. (P.C.H.)

25472 (AFSWC-TDR-62-137) USAF SHIELDED CAB VEHICLES— TEST AND EVALUATION. John P. La Follette and Joseph L. Dufour (Air Force Special Weapons Center, Kirtland AFB, N. Mex.). Feb. 1963. 258p.

Three shielded-cab vehicles were tested at the Nuclear Rocket Development Station, Mercury, Nevada, to determine their operational capabilities in radioactive fields. Testing was concentrated on the "Beetle," a shielded-cab vehicle with manipulators. The "Masher," a shielded T-51 Tank Recovery Vehicle, and the "Bat," a shielded Coleman Tow Vehicle, were also tested. All three vehicles were tested for maneuverability, reliability of operation, operational uses, and radiation shielding integrity. The results of the tests, in general, were satisfactory. The complexity of the Beetle requires a continuous preventive maintenance program to ensure its reliability. (auth)

25473 (BNL-780) MEDICAL SURVEY OF RONGELAP PEOPLE EIGHT YEARS AFTER EXPOSURE TO FALLOUT. Robert A. Conrad, Leo M. Meyer, Wataru W. Sutow, William C. Moloney, Austin Lowrey, A. Hicking, and Ezra, Riklon (Brookhaven National Lab., Upton, N. Y.). Jan. 1963. Contract [AT(30-2)-Gen-16]. 76p. (BNL-T-296)

Results are presented of a medical survey of the people of Rongelap in the Marshall Islands, carried out in March 1962 at 8 years after accidental exposure to fallout from a high yield thermonuclear device during Castle Operation in the Pacific Proving Grounds in March 1954. Sixty-four inhabitants of Rongelap, 105 nautical miles from the detonation, received an estimated dose of 175 r of whole-body γ radiation, contamination of the skin sufficient to result in beta burns, and slight internal absorption of radioactive materials through inhalation and ingestion. Eighteen Rongelap people on a nearby island received an external γ dose of about 69 r, and 157 Marshallese on Utirik Island received an estimated dose of 14 r whole-body radiation. The fallout was not visible on this island and no skin effects developed. Findings are summarized of surveys made during the preceding 7 years. Findings are compared with those on comparison populations of Marshallese people. Data are presented from physical examinations, a cancer detection and leukemia survey, growth and development studies in children, ophthalmological examinations, studies on residual beta burns, a dental survey, studies of aging criteria, and estimation of body burden of Sr^{90}. Findings persisting in the exposed population include incomplete recovery of certain blood elements to levels found in the unexposed people, retardation of growth and development in some of the irradiated children, and pigmented changes at the sites of radiation burns of the skin. (C.H.)

25474 (CLOR-13) WATER RADIOACTIVITY, POLAND, 1961. R. Szepke, M. Bysiek, and D. Grzybowska (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). 1962. 32p.

Measurements were made on dissolved and suspended gross beta activity in river-, ground-, pond-, and tap-water samples collected in 1961. In addition, data on the radiostrontium content in drinking water samples collected from July 1960 to September 1961 are given. The data are tabulated and evaluated by the graphic statistical method. (P.C.H.)

25475 (HW-SA-3015) HEALTH AND SAFETY GUIDES FOR CHEMICAL HANDLING: THE RARE EARTH METALS AS AN EXAMPLE. R. H. Scott (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [1963]. Contract AT(45-1)-1350. 11p.

Information about health and safety considerations in handling the rare earth metals is used to exemplify the application of Chemical Safety Guides in a research-oriented industrial environment. Data on toxic effects of rare earth citrates on guinea pigs are included. (P.C.H.)

25476 (LAMS-2870) BETA-GAMMA RADIOACTIVITY IN ENVIRONMENTAL AIR AT LOS ALAMOS, NEW MEXICO, FOR 1962. Jack W. Aeby and W. R. Kennedy (Los Alamos Scientific Lab., N. Mex.). Mar. 1, 1963. Contract W-7405-eng-36. 22p.

Data are presented from measurements of air particulate radioactivity, activity in precipitation, and γ background at Los Alamos Scientific Laboratory during 1962. (C.H.)

25477 (NARF-62-18T) HEALTH PHYSICS ACTIVITIES, OCTOBER 1, 1960 TO SEPTEMBER 30, 1962. W. R. Miller, comp. and ed. (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Jan. 1963. 102p.

The routine assessment and control of radiation at the Nuclear Aerospace Research Facility are discussed. Information and data on such subjects as monitoring techniques, internal and external hazard levels, personnel monitoring, dosimetry, health physics instruments, environmental monitoring techniques, decontamination techniques, bioassay and special analysis, waste disposal, area monitoring, radioisotope control, and administration programs are included. (N.W.R.)

25478 (NP-12799) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 1, Number 5. (Canada. Dept. of National Health and Welfare. Radiation Protection Div., Ottawa). May 1963. 39p. In English and French.

Analytical results are presented on fallout monitoring in Canada during March and April, 1963. Data are also included on reactor environment monitoring, personnel dosimetry, isotope safety assessments, and field investigations of radiation safety. (C.H.)

25479 (NP-12871) RADIATION PROTECTION NORMS. (European Nuclear Energy Agency, Paris). 1963. 44p.

The Recommendations of the International Commission on Radiological Protection serve as a basis for maximum permissible radiation dose values and limits of concentration of radionuclides in air and drinking water. Values are also presented for occupational radiation exposure in controlled areas. (C.H.)

25480 (NP-12879(Rpt.4)) ESTIMATES AND EVALUATION OF FALLOUT IN THE UNITED STATES FROM NU-

CLEAR WEAPONS TESTING CONDUCTED THROUGH 1962. (Federal Radiation Council, Washington, D. C.). May 1963. 33p.

The Federal Radiation Council made a full study and analysis of fallout expected in the current year from nuclear tests in the past. In this case the report covers fallout expected in the next few years from Soviet and United States tests conducted to date. Although absolute fallout levels in the U. S. in 1963 will probably be substantially increased over 1962 if rainfall is normal, they will still be, in relative terms, far short of figures which would cause concern or justify counter-measures. Cumulative whole-body radiation doses from all past tests is estimated to be 110 millirems in 30 years, which is about one-thirtieth the exposure from natural sources such as soil, rocks, and building materials. The special cases of iodine-131 and strontium-90, the two radionuclides of most concern to the public, have been thoroughly reviewed and specifically included in the general conclusion. The Council concludes that the health risks from radioactivity in foods, now and over the next several years, are too small to justify countermeasures to limit intake of radionuclides by diet modifications or altering the normal distribution and use of food, particularly milk and dairy products. The substantial increase in absolute amounts of fallout is due primarily to Soviet nuclear tests. The amount of fission yield in the thermonuclear test explosions is a measure of the quantity of strontium-90 and other fission products produced by the tests. The total yield of thermonuclear explosions is a measure of the carbon-14 produced. Since the Soviet Union ended the three-year moratorium by resuming nuclear tests in 1961, Soviet testing has produced 85 megatons of fission yield, and U. S. testing 16 megatons. This report updates weapons testing information to include all tests conducted through 1962. The USSR conducted atmospheric tests at levels of 120 megatons (MT) total yield and 25 MT fission yield in 1961; 180 MT total yield and 60 MT fission yield in 1962. A few of the underground tests conducted by the U. S. in 1961 resulted in some venting to the atmosphere. The U. S. conducted a series of atmospheric tests in the Pacific at a level of 37 MT total yield and 16 MT fission yield in 1962 plus a few low yield tests at the Nevada Test Site. Measurements of strontium-90 in food supplies and the total diet in the U. S. show that the levels rose from a value of 4 to 8 strontium units (SU) in 1961 to 8-13 SU in 1962, and may rise to a peak value of 50 SU in 1963. The predicted concentrations of strontium-90 in milk for 1963 are twice the values observed in 1962 and about 4 times the values observed in 1961. The strontium-90 concentrations in human bone are expected to rise from an observed value of 2.6 SU in 1961 to 7 SU in 1964. The presently estimated radiation dose to bone from all past tests is about 465 millirems in 70 years, which is about one-twentieth the exposure from natural sources. It should be noted that these presently predicted values are no greater than those which were predicted in the FRC Report No. 3 as likely to result from all tests conducted prior to 1962. This is because the measured levels are lower than originally predicted. It was estimated in 1962 that carbon-14 resulting from tests conducted through 1961 would give an average per capita radiation dose to the whole-body including the reproductive cells of 10 to 15 millirems in the first 30 years. It is now estimated that the carbon-14 produced by testing conducted in 1962 will produce a comparable radiation dose in the first 30 years. When the carbon-14 now in the atmosphere has equilibrated with the oceans, the natural levels will be increased by about 4 percent instead of the 2 percent previously reported. (auth)

25481 (TID-18683) EVALUATION OF THE RADIATION HAZARD FROM URANIUM GLAZES. Robert C. Magor (Michigan. Univ., Ann Arbor. School of Public Health). May 17, 1963. 21p.

An investigation was made of the radiation hazard from ceramic dishes coated with a glaze containing uranium. The surface beta dose-rate of the dishes was measured using commercial film badges and an extrapolation chamber, and was calculated from the surface beta activity of the dishes. The surface beta activity was determined, first, from the count-rate of the glaze at zero absorption, using a G-M tube calibrated at zero absorption, and, second, from the measurement of the $Pa^{234}(UX_2)$ activity of the glaze, using a calibrated electroscope. The surface dose-rate was found to 17 mrad/hr through an absorption thickness of about 60 mg/sq cm using film badges, 15 mrad/hr through 3.4 mg/sq cm using an extrapolation chamber, and 12 mrad/hr through 7.0 mg/sq cm by calculation from the surface beta activity. The surface beta activity was found to be 1.4×10^{-3} and 1.7×10^{-3} uc/sq cm by the two methods. Results indicate that prolonged contact with ceramic dishes coated with a glaze containing uranium can result in a significant beta radiation dose, but the possibility of a significant beta radiation dose from the ingestion of the glaze is remote. (C.H.)

25482 (TID-18708) DENTAL EDUCATION IN THE PROPER USE OF IONIZING RADIATION. Karl Z. Morgan (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 35p.

Recent developments in the field of radiation protection applicable to reducing radiation exposure from dental x rays are reviewed. State control programs governing the operation of x-ray machines are discussed. (C.H.)

25483 (TID-18759) LOSS OF I-131 FROM FALLOUT-CONTAMINATED VEGETATION. William E. Martin (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [May 31, 1963]. Contract AT(04-1)-Gen-12. 19p.

While the radioactive half-life of I^{131} is 8.04 days, its effective half life on fallout-contaminated vegetation was found to be only 5.5 days. Experimental evidence indicated that the difference may have been due to the mechanical removal of particles from vegetation and/or to the vaporization of I-131 from particles retained by vegetation. These findings imply that I-131 and other radionuclides contained in fallout may be lost from the diets of herbivores at rates significantly greater than could be predicted on the basis of radioactive decay alone. (auth)

25484 RADIATION PROTECTION IN CHEST ROENTGENOGRAPHY: A STATEMENT OF THE COMMITTEE ON RADIATION EFFECTS. Richard H. Chamberlain, W. Edward Chamberlain, Benjamin Felson, Clinton C. Powell, James G. Somerville, Walter R. Stahl, Francis J. Weber, and Joseph B. Stocklen (American Thoracic Society, National Tuberculosis Assn., New York). Am. Rev. Respirat. Diseases, 86: 592-3(Oct. 1962).

A revision of an earlier statement of the American Thoracic Society issued in July, 1959, is reported. It is believed that there is no reason to curtail properly designed programs employing tested and approved apparatus and techniques because of potential radiation hazards, but special attention to program design is indicated for persons especially susceptible to radiation effects, such as pregnant women and children. Suggestions are given for reducing radiation exposure to a minimum. It is recommended that: the small amount of x-ray exposure that accompanies properly performed chest roentgenography

should not interfere with the benefits to be derived from a well-designed case-finding or diagnostic program; mirror optics or 14- by 17-in. equipment be used for tuberculosis control programs; a thorough radiation safety survey by a properly qualified person, followed by appropriate corrective action, should be repeated at regular intervals and whenever changes are made in equipment; personnel should be trained in proper operation of equipment, including the use of protective devices, and in optimal film processing techniques, to keep diagnostic value high and radiation exposure low. (TCO)

25485 ON THE QUESTION OF THE MINIMAL INJURING DOSE FOR CHRONIC EFFECTS OF SMALL AMOUNTS OF X OR GAMMA RADIATION ON HIGHER ORGANISMS. H. Langendorff. Atomkernenergie, 8: 183-9(May 1963). (In German)

The question of the effect of x and gamma rays on higher organisms and man in small radiation quantities over long periods of time is considered. The aim of the investigation was to demonstrate that relatively large total radiation doses are required in such a case in order to induce late radiation effects. The analysis of the observation material available showed that the occurrence of a late radiation effect depends not only on physical factors but to a great extent also on a great variety of biological factors. An attempt was made to establish dose limiting values. If these were surpassed, late radiation effects of certain types, such as changes in the blood count, leukemia, tumor growth, fertility disorders, etc. occur. However, the experiences are not yet comprehensive enough to draw conclusions with respect to radiation danger to man by small radiation doses over long periods of time since animal experiments were made almost exclusively. Statistics on the occurrence of late radiation effects in man under the conditions stated are practically non-existing. The results gained from animal experiments indicated that the induction of a late radiation effect depends on the transgression of a threshold dose. The size of this dose, in turn depends on the total irradiated dose and the dose rate used and the physiological condition of the irradiated object. The attempt to find, on the basis of the listed experiments and experiences, an upper dose limit after the transgression of which a late radiation effect of the type mentioned can be expected in man, led to the result that such a threshold value should be around 200 r, provided that the radiation effect extends over a longer period, such as a few months. Transgressions of the maximum dose established legally in the Federal Republic for professionally radiation-endangered persons therefore seem justifiable in danger situations up to the threshold dose stated and in adherence to the stated conditions. (auth)

25486 LEAD DECONTAMINATION. P. Cerré, E. Mestre, and J. Courtault. Bull. Inform. Sci. Tech. (Paris), No. 69, 49-58(Feb. 1963). (In French)

A study was made of the methods of absolute decontamination due to the large amounts of lead protection used in nuclear industry. Decontamination by sand blasting or by steam was replaced with a decontamination of the lead by fusion. Decontamination by chemical methods in the laboratory was also studied. The two processes and the results obtained are described. (P.C.H.)

25487 CONSIDERATIONS ON THE VALUE AND PRACTICAL USE OF REINFORCING SCREENS IN RADIODIAGNOSIS. Z. Petkovic. Dia Med. (Buenos Aires), 34: 1315-19(July 19, 1962).

The use of reinforcing screens for image intensification and diminution of x-ray doses to the patient is discussed. (H.H.D.)

25488 THE USE OF HELICOPTERS FOR EMERGENCY DISTRICT SURVEY AFTER AN ACCIDENTAL RELEASE OF RADIOACTIVE MATERIAL. B. A. J. Lister (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Health Phys., 9: 309-14(Mar. 1963). (In English)

The possible use of helicopters in carrying out rapid district gamma radiation surveys was studied using standard portable equipment operated by regular health physics operations staff. Measurements have been made of radiation levels at various heights up to 1000 feet above point sources of iodine-131 and caesium-137 and above arrays of iodine-131 sources. The results show than an area contaminated to a level of 0.4 μc iodine-131/m^2 (corresponding to the imposition of emergency restrictions on milk consumption) can be readily detected using a scintillation ratemeter at a height of 50–100 ft. This sensitivity is similar to that which can be obtained using a fixed wing aircraft at 500 ft employing more elaborate techniques. The type of helicopter used is available as a continuous emergency service operated by the Royal Air Force. Operational flying tests have indicated the main problems which would be met during an emergency survey, and the advantages to be gained from the use of helicopters either in close support of a carborne survey or in areas where a carborne survey is impracticable. A suitable technique for such an aerial survey has been worked out and an agreement for assistance now exists between A.E.R.E. Harwell and R.A.F. Coastal Command. (auth)

25489 KENTUCKY'S RADIOLOGICAL SAFETY PROGRAM. Charles L. Weaver (Kentucky State Dept. of Health, Frankfort). Health Phys., 9: 349-53(Mar. 1963).

On March 25, 1960, Kentucky became one of the first states to pass enabling legislation allowing the Governor to set up a regulatory program and enter into an agreement with the Atomic Energy Commission to take over radiation safety control. The organization and administration of the radiological safety program are discussed. (C.H.)

25490 RADIATION SAFETY IN A UNIVERSITY. John R. Prince (Oregon State Univ., Corvallis). Health Phys., 9: 347-9(Mar. 1963).

A survey of the administrative structure of radiation safety programs and regulations of many colleges and universities showed that universities vary considerably in the organizational structure of their radiation protection programs. The need is stressed for the technical evaluation of each program using ionizing radiation and the establishment of an effective control program. (C.H.)

25491 AIR PURIFYING RESPIRATORS FOR PROTECTION AGAINST AIRBORNE RADIOACTIVE CONTAMINANTS. E. C. Hyatt (Los Alamos Scientific Lab., N. Mex.). Health Phys., 9: 425-32(Apr. 1963). (In English)

Respiratory protective devices for protection against airborne radioactive contaminants have been in use for approximately 20 years but have not been tested and approved by any government agency. The U. S. Bureau of Mines proposed approval program and current activities for such devices are discussed. The AEC Respirator Committee specifications for respiratory protective devices against highly toxic contaminants and some current activities to test commercially available devices in relation to these specifications are discussed. The Harvard test results and results of the LASL respirator fitting tests are given. Discussion of the Navy Mark V gas mask, and results of LASL tests with commercial masks at temperatures down to –30°F are

presented. Limitations on selection and use of respirators are discussed. (auth)

25492 PRE-PLANNING FOR NUCLEAR ACCIDENTS. J. M. White and J. Neil (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys., 9: 507-9(May 1963). (In English)

The improvements in emergency planning and equipment at Chalk River which have occurred during the last 15 years are discussed. Reference is made to how well emergency plans operated during the two major reactor accidents which occurred. The existing procedures which deal with emergencies are discussed and some of the emergency equipment designed and built at Chalk River by the Radiation and Industrial Safety group is described. (auth)

25493 CINCINNATI'S RADIOACTIVE FALLOUT MONITORING PROGRAM. Charles W. Gruber and Charles E. Schumann (Hamilton County Civil Defense Organization, Cincinnati). J. Air Pollution Control Assoc., 13: 195-7 (May 1963).

Two aspects of Cincinnati's fallout monitoring program are discussed: monitoring in the event of a nuclear attack and routine daily monitoring of fallout. The history of the Hamilton County civil defense and Cincinnati air pollution organizations is described. The network of monitoring stations and the training program are discussed. A continuous air monitor for beta activity is described. Fallout data collected as a part of the National Air Sampling Network are given. (D.L.C.)

25494 PUBLIC HEALTH SERVICE NATIONAL FALLOUT SURVEILLANCE PROGRAM. John C. Villforth (Public Health Service, Washington, D. C.). J. Air Pollution Control Assoc., 13: 222-7(May 1963).

It is shown that the Public Health Service, through its system of federal-state surveillance networks, is capable of immediate nationwide assessment of the levels of radioactive contamination in the environment. A review of the actions taken in response to the Soviet tests last fall has shown how the Radiation Surveillance Network operates as an "alert" to the need for increased monitoring by other surveillance systems. A comparison of the levels of the principal radionuclides in milk with the ranges established by the Federal Radiation Council has indicated that control measures are not warranted at present. However, expanded federal and state surveillance capabilities are needed (1) to determine when and in what areas control measures should be initiated; and (2) to carry out continuous monitoring in order to guarantee the effectiveness of such measures once they have been instituted. This increased surveillance effort at the federal and state levels will help assure an improved program to deal with hazards from nuclear weapons testing. (auth)

25495 CONTAINMENT AND CONTAMINATION CONTROL IN THE NUCLEAR INDUSTRY. J. C. Lang. J. Am. Assoc. Contamination Control, 2: 6-8; 23(Feb. 1963).

Various sources of radiation are defined, and the facilities and equipment for containing and handling radioactive materials are described. (Public Health Engr. Abstr., Vol. 43, No. 5, May 1963)

25496 HOSPITAL RADIOLOGIC DECONTAMINATION CENTER. Jack R. Karel and Sidney Ketyer (Medical Society of New Jersey, Hillside). J. Med. Soc. New Jersey, 59: 473-4(Aug. 1962).

In 1961 the Medical Division of the Union County Civil Defense and Disaster Control organization in cooperation with the Radiology Department of St. Elizabeth Hospital in Elizabeth, N. J., developed a Hospital Decontamination Center. In addition to being a decontamination center, St. Elizabeth Hospital has become a fallout monitor station for Union County. According to the proposed procedure, upon entering the hospital, the contaminated individual would be taken to a reception room where he would be disrobed. His body would be completely checked for radiation. Clothes would be placed in a covered metal can and then taken to a storage room. The floor of the reception room should be coated with a peelable paint so that if heavily contaminated, it can be readily removed. A floor drain should be installed to aid in decontamination, leaving the stripping of the paint as a last resort. Emergency surgical instruments, drugs, plasma, and parenteral fluids should be available in this room for treatment of any injury. From the reception area, the patient would be taken to a special shower room containing a bathtub and shower combination in a glass enclosure. After this, the radioactive patient would be taken to a specially located hospital room for observation and treatment. Heating, air conditioning, or ventilation ducts should be completely separate from those of the rest of the hospital to prevent the spread of airborne radioactivity. The radiologic treatment team may consist of 2 radiologic safety officers from the Radiology Department, 2 internists, 1 hematologist, and 1 general surgeon. (TCO)

25497 SAFETY MEASURES DURING WORK WITH CLOSED RADIOACTIVE SOURCES IN THE CLINIC. A. Ya. Berlovskii (Inst. of Medical Radiology, Khar'kov). Med. Radiol., 8: No. 4, 68-73(Apr. 1963). (In Russian)

An attempt at complete mechanization of the work process in the production of applicators from radioactive cobalt beads is described. The process of assembling and sterilization of the applicator until its administration to the patient is closed and occurs outside of the field of vision of the nurse. The whole process is controlled by a signal device. (auth)

25498 PROTECTION AGAINST RADIATION INJURY. F. C. Pace and W. R. Waters (Dept. of National Health and Welfare, Ottawa). Med. Serv. J. (Can.), 17: 597-609(Sept. 1961).

An account is given of the principles of protection against radiation injury and of the recommendations of Emergency Health Services, Department of National Health and Welfare, to those responsible for the protection of the health of persons at risk from nuclear weapon fallout radiations. Protection against injury is based on 2 concepts: procedures that result in avoidance of injurious exposures, and the establishment of levels of dosage that an individual should not exceed if injury is to be avoided. Owing to the long range of gamma radiation and its penetrating power, the avoidance of dangerous dosage can only be achieved by effective shielding. An analysis was made of various structures to determine their protective factor, and data are given for a number of typical Canadian domestic buildings. Recommendations for dosage control of the general public and of civilian and military operational personnel have been made. Protection against contact injury from β radiation is also discussed as well as hazards of ingestion of radionuclides. A shelter that will provide protection against γ radiation will also protect against β radiation, but, unlike that for γ radiation, shielding against β radiation can be effectively achieved by material as simple as ordinary textiles. Decontamination of exposed skin and protection of food and water supplies from fallout are also considered. (TCO)

25499 RADIOACTIVE CLOUDS AT GREAT HEIGHTS. E. Keppler and G. Pfotzer (Max-Planck-Institut für

Aeronomie, Lindau, Ger.). Naturwissenschaften, 50: 220-1 (1963). (In German)

The results of high-altitude measurements made at Göttingen with a single counter tube from Oct. 15 to 29, 1962, at heights from 16 to 25 km are reported. Counting rates much higher than normal were observed. The counting rates in excess of the usual cosmic background were determined as a function of the height. The results indicate the presence of one or more layers of increased radioactivity with well-defined boundaries. The origins of the radioactive clouds are discussed. (J.S.R.)

25500 ON THE PROBLEM OF THE RADIATION HAZARD OF RADIUM WATCH DIALS. G. Fuchs (Zentralroentgeninstitut des Kaiser-Franz-Joseph-Spitals, Vienna). Radiol. Austriaca, 12: 153-6(1961).

Dose measurements and calculations are presented concerning wrist watches with luminous dials and the possible radiation hazards are discussed. The dials generally bear ~1 μC Ra, which gives a γ-radiation dose of 8.5 mr/hr at a distance of 1 cm. It is estimated that on the average the watch will be worn 14 hr/day, which is equivalent to 5000 hr/yr, so that the yearly dose at 1 cm would be 42.5 r. At an average gonadal distance of 35 cm, the yearly gonadal dose would be 35 mr. Other reported estimates of the yearly gonadal dose have varied from 5 to 30 mr. In view of the possible genetic effects of the radiation, it was concluded that the dubious advantages of luminous watch dials are not worth the risk involved and should be discarded. The genetic hazards are of greater consequence to future human populations than to the individual who wears such a watch. (H.H.D.)

25501 A DECONTAMINATION APPARATUS FOR RADIOISOTOPE LABORATORIES. I. Szantai and Cornelia Gherman. Rev. Chim. (Bucharest), 14: 161-3(Mar. 1963).

A decontamination apparatus built to avoid the accidental contamination of handlers by accidental direct contact or through atmospheric aerosols is described. The decontaminator is made entirely of plexiglass plates, can be applied to laboratory sinks as fully closed systems, and offers absolute protection against beta radiations. A lead screen may be added when gamma radiation is present. (OTS)

25502 SAFETY MEASURES IN THE RADIOLOGICAL WORK. Irwin Laurie. Salud Ocupacional, 7: 15-18(Jan.-Mar. 1962).

Basic safety measures to be considered for the protection of the operator as well as patients when x-ray machines are used for diagnosis and medical treatment are discussed. (Public Health Engr. Abstr., Vol. 43, No. 5, May 1963)

25503 HOLDER FOR MOVABLE RADIOACTIVE SOURCE MATERIAL. Donald C. Brunton (to Curtiss-Wright Corp.). U. S. Patent 3,088,032. Apr. 30, 1963. Filed July 27, 1959.

An apparatus for shielding and exposing radioactive material and moving it between the shielded and unshielded positions is patented. The source of radioactive material is conveyed from the shield to the source holder by introducing compressed air into the passageway containing the source. It is returned to the shield by a motor-operated recovery reel, which winds up the cable attached to the source. Details of the design of the shield, source holder, connecting passageways, and propelling means are presented. (M.P.G.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

Refer also to abstract 25031.

25504 (AD-285212) INVESTIGATION OF RELATIVE MICROBIOLOGICAL RESPONSE TO VARYING TYPES AND METHODS OF APPLICATION OF IONIZING RADIATION. Report No. 8 (Final). Lloyd L. Kempe (Michigan. Univ., Ann Arbor). Nov. 30, 1961. Contract DA-19-129-qm-1532. 71p.

The influences of field strength, radiation energy, and intermittent irradiation on the lethality of gamma rays for Clostridium botulinum 62A and 213B spores were evaluated. Three cobalt-60 and one cesium-137 radiation sources were used for this purpose. Variation in field strengths from 0.002 to 2.31 megarad per hour were utilized in the cobalt-60 sources. None of these variables was found to affect significantly the lethality of gamma rays for C. botulinum spores. Insofar as the sporicidal effect of gamma radiations are concerned, the results show that data obtained on moderately weak radiation sources can be extrapolated for design purposes to field strengths of at least 2.31 megarad per hour; that interruption of irradiation for short intervals has little effect; and that cesium-137 should be essentially as effective as cobalt-60 sources for food-sterilization purposes. (auth)

25505 (CLOR-16) HIGH-SPEED PLANKTON SAMPLER, TYPE CLOR. St. Wlodek and Z. Szwaj (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). 1963. 10p.

Design features are described for a high-speed plankton collector for use in sample collection for radiometric studies. (C.H.)

25506 (NCSC-2477-3) APPLICATIONS OF NUCLEAR RADIATION AND RADIOISOTOPES TO TEXTILE MATERIALS AND PROCESSES. Quarterly Report, March 1, 1961–May 31, 1961. Arthur A. Armstrong, Jr. and Henry A. Rutherford (North Carolina State Coll., Raleigh. School of Textiles). June 30, 1961. Contract AT(40-1)-2477. 16p.

The rate of graft polymerization of acrylonitrile to cotton is increased by both partial acetylation and cyanoethylation but is unaffected by partial methylation and carboxymethylation. In the instance of acetylation the rate of grafting is about proportional to the degree of substitution. Gamma radiation of cotton inhibits micro-organism attack for a short period of time and retards the rate of spore growth. The inhibition is lost on standing for several weeks or on washing in water. The accuracy of activation analysis in the measurement of variability in a set of 16 samples is not sufficient to measure a coefficient of variation of 1%. At the 5% level of coefficient of variation the error in the experimental value is ±30% of the actual value; at the 10% level of coefficient of variation, the error is ±15% of the actual value. It was therefore concluded that activation analysis would not give the accuracy necessary to measure the variability in the blending of different fibers as influenced by spinning conditions or procedures. Gamma spectra were obtained on various textile fiber samples for the long-life isotopes in the lower energy levels after 10 hr activation at 10^{11} n/cm^{2}sec. Inspection of the list of isotopes identified in the various fibers shows some minor differences. However, in general it would be difficult for positive identification of a fiber from these spectra. (auth)

25507 (TID-7657) RADIATION PASTEURIZATION OF FOODS, SUMMARIES OF ACCOMPLISHMENT PRESENTED AT SECOND ANNUAL CONTRACTORS MEETING, OCTOBER 24 AND 25, 1962. (Division of Isotopes Development, AEC and Division of Biology and Medicine, AEC). 96p.

Separate abstracts were prepared on 10 sections of this report. (C.H.)

25508 (TID-7657(p.4-13)) EFFECT OF RADIATION PASTEURIZATION DOSES ON STORAGE LIFE EXTENSION OF MARINE PRODUCTS. J. T. R. Nickerson (Massachusetts Inst. of Tech., Cambridge).

Investigations on the effects of radiation processing on the storage life of haddock fillets and shucked, soft-shelled clams held at 43 to 46°F and at 32 to 33°F after irradiation showed that a radiation dose of 50,000 rad increased storage life by one day or less but a radiation dose of 800,000 rad increased storage life from 60 to 80 days over that of controls. Storage life was longer at 32° than at 43°F. The samples were packaged in polyethylene bags with free access to oxygen. A classification is presented of bacteria present before irradiation, immediately after irradiation, and after irradiation and refrigerated storage. (C.H.)

25509 (TID-7657(p.14-20)) STUDY OF RADIATION PASTEURIZED FISHERY PRODUCTS. Joseph W. Slavin (Fish and Wildlife Service. Technological Lab., Gloucester, Mass.).

Radiation doses of 450,000 rads increased the storage life of soft shell clam meat held at 33°F from 5 to 30 days. Radiation levels of 350,000 rads increased the storage life of haddock fillets at 33°F from 11 to 30 days. The products were irradiated in enamel-lined cans. Vacuum-packed irradiated products had the same storage properties as air-packed. Storage of irradiated products at 42°F resulted in relatively rapid spoilage and low acceptability. (C.H.)

25510 (TID-7657(p.21-5)) RADIATION PASTEURIZATION OF SHRIMP. Arthur F. Novak (Louisiana State Univ., Baton Rouge).

Radiation doses of 50,000 to 100,000 rads resulted in an increase in the iced storage life of shrimp of at least 2 weeks over untreated controls. When shrimp were irradiated within 12 hr after being caught, the storage life was extended by another week. An attempt was made to identify bacteria that survived irradiation. The effects of handling and storing on the quality of the irradiated product are discussed. (C.H.)

25511 (TID-7657(p.26-31)) RADIATION PASTEURIZATION OF PACIFIC CRAB AND FLOUNDER. PART I. APPLICATION OF RADIATION-PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER. David T. Miyauchi (Fish and Wildlife Service. Technological Lab., Seattle). PART II. EFFECTS OF IONIZING RADIATION ON LIPIDS OF FISH. Virginia Stout (Fish and Wildlife Service. Technological Lab., Seattle).

Results are reported from studies on the effects of radiation processing on the storage life of crab meat and sole fillets irradiated in hermetically sealed cans or polyethylene pouches and stored at 33 or 42°F. The usual type of fresh fish spoilage was inhibited in samples where a combination of higher irradiation dose and low storage temperature was used. Preliminary results are included from studies on the effects of low-level radiation doses on selected fish lipids. (C.H.)

25512 (TID-7657(p.32-50)) RADIATION PASTEURIZATION OF FRUITS AND VEGETABLES. E. C. Maxie and Noel F. Sommer (California. Univ., Davis).

The Mark II irradiator was used in studies of radiation pasteurization of fruits and vegetables. Results are reported on permissible dose; effects of radiation processing on storage, extension of shelf life and quality; treatment variables; and the evaluation of the factors involved in the various responses noted. Data are given on effect of radiation processing of lemons, oranges, strawberries, peaches and nectarines, grapes, tomatoes, pears, figs, pineapples, papayas, sweet cherries, and asparagus. Results are included from studies of γ dose response of the most important fungi inciting post-harvest decay of fruits and vegetables conducted by experiments with inoculated fruits. (C.H.)

25513 (TID-7657(p.51-8)) MARKETING FEASIBILITY STUDY OF RADIATION PROCESSED FRUITS AND VEGETABLES. John H. Droge.

Growers, shippers, wholesalers, and retailers of fruits and vegetables were surveyed for preliminary opinions on the economic feasibility of marketing radiation pasteurized fresh strawberries, peaches, tomatoes, grapes, oranges, and grapefruits. The survey results suggest that an educational program would be essential in order to acquaint the public with the process. (C.H.)

25514 (TID-7657(p.59-61)) STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS INVOLVED IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS. A. M. Dollar and J. Liston (Washington. Univ., Seattle. Coll. of Fisheries).

Preliminary results are reported from investigations on the microbiological and biochemical factors involved in the radiation pasteurization of marine products. Results are presented from studies on the bacteriology of unirradiated and irradiated samples of Pacific flounder. Studies were made on the radiosensitivity of pure cultures of bacteria isolated from irradiated flounder. Studies were completed on the dose geometry for 3 containers used in the studies. (C.H.)

25515 (TID-7657(p.62-6)) THE BIOCHEMISTRY OF RADIATION AND FRUIT MATURATION. Roger J. Romani (California. Univ., Davis).

Several types of fruits were examined for respiration rate during irradiation. Measurements were also made of the quantitative changes in intracellular particles of irradiated fruit and radioinduced changes in enzyme content, fatty acid composition, and pectin properties. The effect of irradiation on fungi causing soft rot of fruits was also studied. Emphasis was placed on factors affecting the storage life of irradiated lemons and peaches. (C.H.)

25516 (TID-7657(p.67-70)) A STUDY OF THE EFFECT OF IONIZING RADIATION ON THE RESISTANCE, GERMINATION AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B AND E. John T. Graikoski and L. L. Kempe (Michigan. Univ., Ann Arbor).

Clostridium botulinum Type E bacteria are distributed in marine environments and have the ability to grow at refrigeration temperatures. Results are reported from a study on the germination, growth, toxin development, and γ radiosensitivity of Type E spores. (C.H.)

25517 (TID-7657(p.71-8)) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34°F. TO 50°F. Clarence F. Schmidt (Continental Can Co., Inc., Chicago).

A study was made of growth and toxin production by Clostridium botulinum Type E in the temperature range 34 to 50°F. Public health hazards involved in the prolongation of refrigerated storage life of marine products by radiation processing are discussed. It is pointed out that spores of this organism are highly radiation-resistant and that if even small numbers of spores survive the low-radiation dose used for processing marine products they can produce toxins and spoilage of the products during refrigerated storage. (C.H.)

25518 (TID-7657(p.79-84)) RADIATION SOURCE DEVELOPMENT PROGRAM. B. Manowitz and O. A. Kuhl (Brookhaven National Lab., Upton, N. Y.).

The development of radiation sources for application in the fields of food technology, biology, medicine, and chemistry is discussed. Source requirements and production rates are presented for a mobile Co^{60} irradiator and a mobile electron accelerator irradiator. (C.H.)

25519 (AEC-tr-5824) VARIOUS APPLICATIONS OF SHORT-LIVED RADIOISOTOPES IN THE STUDY OF METALS. A. Kohn. Translated from p.285-304 of "Proceedings of the Seminar on Production and Use of Short-Lived Radioisotopes from Reactors, held in Vienna, November 5-9, 1962. Vol. I" (a publication of the International Atomic Energy Agency, Vienna, 1963). (STI/PUB/64(Vol.I) (p.285-304)).

Examples of applying shortlived radioisotopes in metallurgy are presented for La assay in steels, investigation of the formation of metal crystals, study of convection currents in industrial ingots during solidification, and study of steel surface enrichment with As during hot oxidation. The methods and results are described. (P.C.H.)

25520 (JPRS-19545) IONIZATION RADIATION IN CROATIAN INDUSTRY. Branko Prpic, Jerka Despotovic, and Hrvoje Cerovac. Translated from Tehnika (Belgrade), 18: 779-82(Apr. 1963). 8p. (OTS-63-21974)

The present state of industrial applications of ionizing radiations in Croatia is reported. Only sealed radioactive sources and x-ray units are used. About fifty workers are exposed to ionizing radiation in industry, the average individual dose being about 600 mrem/yr. The principles of radiological protection in industry are reviewed and the importance of the integrity of the physical, technical, and medical survey is discussed. (auth)

25521 A NEW NOMOGRAM FOR γ-RAY FLAW DETECTION. Slavcho Popov (Laboratory for the Application of Radioisotopes in Mechanical Engineering, Sofia). At. Energ. (USSR), 14: 418-19(Apr. 1963). (In Russian)

The currently used nomograms present a correlation in rectangular coordinates between the thickness of the goods, examined for flaw detection and the exposure time in Ra gram equivalent hours, at a given distance F cm between the source and the photographic emulsion. It is difficult to determine the actual duration t of the exposure and the required activity Q of the source from these data. A nomogram was therefore developed, which presents a specific example for the case involving the examination of steel or cast iron goods with a Co^{60} source. The activity values in

the 0.1 to 10 gram equivalent Ra range, plotted on a logarithmic scale, the focusing distance F from 10 to 120 cm and the exposure time from 0.1 to 100 hours are correlated on the graph. A combined nomogram, for use with Ir^{192}, Tu^{170}, Eu^{152}, and Co^{60} sources is also presented; it is applicable for examining goods made of cast iron and Al. (TTT)

25522 IMPURITIES IN RADIOACTIVE PREPARATIONS. P. Koeppe (Freie Universität, Berlin). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 98: 624-30(1963). (In German)

An account is given of some cases of radioactive impurities in radioactive preparations. The possibility that such impurities may be due to long-lived radionuclides must be considered in clinical applications and particularly in dealing with residues and containers (glass-ampulla). (auth)

25523 ANALYSIS OF THE DETERIORATION-PREVENTING BEHAVIOR OF INSULATING OILS BY MEANS OF RADIOACTIVE TRACERS. Hiroaki Kamiyama and Teruo Seki. Genshiryoku Kogyo, 9: 49-53(1963). (In Japanese)

Radioactive tracers were used for investigating the mechanism of adsorption of the products resulting from the deterioration of transformer oils on activated alumina. The amount of the adsorbed organic acids was determined on the basis of activity measurements and the acidity by labeling one of the acids in the system with C^{14}. The behavior of caprylic, stearic, naphthalic, and benzoic acids was studied. The results indicated that the adsorption follows closely Langmuir's adsorption isotherm. The participating acids competed with each other and the benzoic acid was more strongly adsorbed than the stearic acid. It was concluded that the adsorption of these organic acids by activated alumina is a chemical adsorption phenomenon. (TTT)

25524 RADIOAKTIVE ISOTOPE IN DER BETRIEBS-MESSTECHNIK (Radioactive Isotopes in Industrial Measurement Techniques). Hans Hart. Berlin, VEB Verlag Technik, 1962. 560p. DM 68.

All industrial measurements, which depend on the absorption and scattering of radiation, are considered. Topics covered include: importance of measuring processes using radioisotopes in production, some important principles of nuclear physics, radiation sources for incorporation in industrial measurement techniques, methods of measuring using radioisotopes, sensitivity and measuring errors, industrially prepared apparatus, examples for industrial inauguration of processes, isotopic measuring apparatus in standard equipment, and protection of workers using radioisotopes. A bibliography with 693 references is included. (M.C.G.)

25525 PRODUCTION AND USE OF SHORT-LIVED RADIOISOTOPES FROM REACTORS. VOL. I. Proceedings of the Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors held at Vienna, November 5-9, 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. Mar. 1963. 436p. (STI/PUB/64(Vol.I))

Thirty papers presented at the Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors are given. Separate abstracts were prepared for 9 papers. Twenty-one papers were previously abstracted for NSA. (M.C.G.)

25526 PRODUCTION OF SHORT-LIVED RADIOISOTOPES. P. C. Aebersold (U. S. Atomic Energy Commission, Washington, D. C.) and A. F. Rupp. p.31-47 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In English)

A review is made of the current literature and a bibliography given. Selected references are cited and comment made on the general techniques currently employed by short-lived radioisotope producers. A distinction is drawn between the large centrally-local high flux reactors and local reactors for producing short-lived radioisotopes; the complementary role of the two is pointed out as, for example, the need for obtaining very high specific activities in special off-site reactors or the need for high-speed transfers and fast processing in local reactors. The equipment and procedures used for irradiating target materials to produce short-lived radioisotopes in the three routinely-operated ORNL reactors are described, as well as those for the High Flux Isotope Reactor (HFIR) now under construction at ORNL, which will have a maximum flux of 5×10^{15} n/cm^2 sec. The use of the HFIR will permit production of certain short-lived radioisotopes of high specific activity. Techniques that were developed for irradiating samples in various kinds of reactors ranging from the 10^{12} n/cm^2 sec air-cooled, graphite reactor to the high flux (10^{14} to 10^{15}) water-cooled, enriched uranium reactors are described. The requirements for sample irradiations in the various kinds of reactors, such as material, method of sealing, handling, method of heat removal, and kinds of sample materials, are discussed. Pneumatic transfer tubes are used for irradiations where cooling requirements are not great and fast transfer is desired. Hydraulic tubes are used for irradiation of samples with greater heat generation, although the speed of transfer is not as great as with the pneumatic tubes. The advantages in using enriched target materials in certain cases are pointed out and several illustrations are given. In some cases, where the target nuclide occurs in low abundance, such as Ca^{46} in calcium (0.003%), great advantage can be obtained by using enriched target materials. This may be of importance to users of lower-flux reactors, since it could be the only way to get an extra factor of 3 to 10 in specific activity in local irradiations. For example, the radioisotope K^{42} could be improved in specific activity from the usual ~10 mc/g in the ordinary low flux (5×10^{11} n/cm^2 sec) to about 100 mc/g by using enriched materials. This would be attractive in cases where the expensive target material can be re-used. Good quality short-lived I^{130} (12.5 hr) can be made in most small reactors by irradiating practically stable fission-product I^{129}, which is relatively cheap and readily available. Chemical and analytical problems in producing short-lived isotopes for fast delivery to non-local users are discussed and the methods and scheduling used at the ORNL Isotopes Development Center are given. (auth)

25527 EXPERIENCES WITH THE IRRADIATION OF AMMONIUM BROMIDE. K. Heydorn (Research Establishment, Riso, Denmark). p.123-39 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In English)

Irradiation of ammonium bromide with slow neutrons is a method for the production of Br^{82} for many purposes. While the majority of the irradiations are carried out in a thermal column, it was found desirable in some cases to increase the specific activity by irradiating in positions close to the reactor core. During one such irradiation, rupture of the irradiation can occurred, resulting in severe contamination of the irradiation tube and also of the air in the reactor hall. Rupture of the irradiation cans re-

quires 8 to 10 atmospheres gas pressure, corresponding to a high degree of decomposition of the target material. An investigation of ammonium bromide irradiations showed that evolution of N_2, H_2, HBr, and Br_2 had taken place, and two series of experimental irradiations were carried out in order to obtain quantitative information on the amounts of gases evolved. Electron irradiations, carried out using a linear accelerator, gave a $G(H_2)$ value of 0.51; this figure is considered valid also for reactor gamma radiation, and approximately so for thermal neutrons. Reactor irradiations indicated little influence from fast neutrons. Hydrogen formation up to 200 cm^3/g was observed, corresponding to a radiation decomposition of approximately 47%. (auth)

25528 PRODUCTION OF IODINE-132 FROM IRRADIATED URANIUM TETRAFLUORIDE. M. Barrachina Gómez (Junta de Energia Nuclear, Madrid). p.159-69 of "Production and Use of Short-Lived Radioisotopes From Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In Spanish)

Instead of the metallic uranium or uranium oxides usually used, UF_4 was the material to be irradiated to produce I^{132}. The reasons for this choice are as follows: it possesses good thermal and radiolytic stability; it is easily soluble in a solution consisting of concentrated hydrochloric acid and boric acid; the dissolution reaction is gentle and without gas release; and the uranium is dissolved as U^{4+} in a non-oxidizing medium, which permits of selective reduction of the telluric acid added as carrier. The above factors greatly facilitate the process of separating the Te^{132}. The method of separating the Te^{132} is as follows: dissolution of the UF_4 in the medium mentioned above; direct reduction of the telluric acid using $SnCl_2$ followed by filtration; re-dissolution of the Te using concentrated hydrochloric acid and hydrogen peroxide; reprecipitation of the Te in a hydrochloric medium using $SnCl_2$ or SO_2, followed by filtration; and final dissolution of the Te in concentrated nitric acid. The nitric solution of tellurium, containing no fission products that were not isotopic with Te^{132}, was fixed on an alumina column and the I^{132} was removed periodically. The fixation of Te^{132} and the elution of I^{132} were studied and the chemical and radiochemical purity of the product obtained was verified. This method can be used with relatively large quantities of UF_4, which compensates for the poor integral fluxes available in research reactors, such as JEN-1, and thus enables sufficient quantities of I^{132}, of the order of 0.5 C, to be obtained in establishments lacking high-flux reactors in almost continuous operation or unable to irradiate enriched uranium. (auth)

25529 PRODUCTION OF IODINE-132 FROM IRRADIATED TEST FUEL ELEMENTS. H. Sorantin, H. Titze, H. Bildstein, and N. Getoff (Austrian Research Assn. for Atomic Energy, Inc., Vienna). p.171-8 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In English)

The preparation of I^{132} from irradiated uranium is described. After irradiation and cooling, Te^{132} was isolated from other fission products and the uranium recovered. Extraction of I^{132} from Te^{132} was performed either by an ion-exchange method or by adsorption on platinum. Purity tests for the product I^{132} are described and examples of applications are reviewed. (auth)

25530 SOME TECHNIQUES FOR ISOLATING AND USING SHORT-LIVED RADIOISOTOPES. F. Nelson and K. A. Kraus (Oak Ridge National Lab., Tenn.). p.191-213 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In English)

Radioisotopes of a large number of elements were used extensively at Oak Ridge National Laboratory in ion exchange, solubility and other physical-chemical studies. The use of short-lived radioisotopes in such studies necessitated development not only of rapid methods of preparing and purifying radioisotopes but also of special techniques for obtaining pertinent information in a relatively short time, often within a few minutes. Some recently-developed methods are described for preparing and purifying short-lived isotopes, particularly those originating from neutron-irradiated materials, including fissionable elements. The latter are sources of a number of useful short-lived radioisotopes, e.g., Mo^{99}, Te^{132}, and methods are described for rapidly isolating these and other fission products in a carrier-free state by ion exchange. Methods of separating short-lived daughter activities from long-lived parents by "milking" techniques, in which the parent is strongly adsorbed on organic or inorganic ion exchange materials, are also described and typical examples discussed, for example, milking of 1.7-hr In^{113} (from Sn^{113}) and 2.6-min Ba^{137} (from Cs^{137}). Two applications involving the use of short-lived tracers in chemical studies are described. The first is a "packed bed" technique for rapidly measuring the solubilities of sparingly soluble salts which were tagged with tracers. Some recent results obtained by the method on the solubility of LaF_3 in HCl and $HClO_4$ solutions are described. The second is a rapid method for measuring diffusion coefficients in liquid systems. Thin, porous porcelain frits are saturated with solution containing a radioisotope, then rapidly eluted with solution not containing tracer. Diffusion coefficients may be calculated from the decrease of counting rate of the frit with time, after calibration with a material of known diffusion rate. Because of the short diffusion path used, the measurements may be completed in substantially less time by this method than by conventional techniques, for example diaphragm cell or capillary tube methods. (auth)

25531 RADIOACTIVE SURFACE LABELLING OF POWDERED MATERIALS BY MEANS OF GOLD-198. B. R. Petersen (Academy of Technical Sciences, Copenhagen). p.269-74 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In English)

The investigation of material transport is often advantageously performed using radioactive tracers. The principle of the method described is the reduction of gold from a solution of Au^{198} on the surface of the material to be labeled, which was pre-treated with stannous chloride. This method was employed for the labeling of quick-lime, cement, and other powdered materials, but a more general application for labeling seems possible. (auth)

25532 SOME APPLICATIONS OF RADIOISOTOPES OF SHORT HALF-LIFE IN THE FRENCH GAS INDUSTRY. C. Tellier (Gaz de France, Paris), G. Courtois, and M. Gasnier. p.357-82 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In French)

For the purpose of keeping rubber jointings in old gas piping systems in good condition, certain hydrocarbides in very weak concentration were injected into the system in the form of aerosols. Bromonaphthalene hydrocarbide labeled with Br^{82} was added in order to determine the reach of the aerosols. The quantity of tracer recovered, on filter-paper discs distributed along the system, was de-

termined by counting with an end-window counter. Four millicuries of bromonaphthalene sufficed to trace the hydrocarbide over a length of 7 km in a conduit 15 cm dia. Municipal gas authorities stipulated a minimum rate of air renewal in domestic premises. For the purpose of checking this rate, Xe^{133} was diffused throughout the premises and the change in concentration was measured by means of a scintillation counter. Concentrations of the order of 0.5 mc/m^3 were sufficient. The reproducibility of results was greatly superior to that obtained with conventional methods. The principle of isotopic methods of leak detection was perfected for industrial purposes by using an experimental pipeline, 140 m in length and 25 cm dia installed underground at Saclay, at a depth of 1.10 m. This pipe has five experimental leakage points, with adjustable discharge, located in different kinds of soil (sand, chalk, clay, local Saclay earth). The first results obtained with this installation are described. A description is given of pressure tests carried out to check water-leak-tightness prior to putting new conduits into service. Na^{24} in the form of bicarbonate was used as tracer, and detection was done from inside the conduit by means of a scraper piston enclosing a self-contained Geiger-counter measuring unit and a magnetic recorder. The difficulties encountered in perfecting this apparatus are described. The graph obtained after decoding showed a very marked peak for every leak, the position of each being determined to within about 2 m. For easy detection, some 20 μc must escape through the leak. To find leakages in mains, methyl bromide labeled with Br^{82}, prepared on the spot and starting with $Br^{82}NH_4$, was used. After injection, the radioactive gas was uniformly mixed by circulation. Detection was performed from ground level by means of portable scintillation counters. The trials, which are continuing, made it possible to determine the activities required and the most favorable schedule for the detection of different types of leak. (auth)

25533 THE USE OF Na^{24} AS A TRACER IN PUBLIC WORKS AND HYDROLOGY. E. Gaspar, M. Oncescu, P. Sandru, L. Grigorescu, M. Birnbaum, and T. Teitel (Inst. of Atomic Physics, Bucharest). p.393-403 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963. (In French)

The work of the Institute of Atomic Physics in Bucharest in the application of short-lived radioisotopes in hydrology is reviewed. Such work includes determination of fluid loss from main water-pipes and investigation of infiltrations into barrages. The determination of the direction and flow velocity of subterranean waters through a sandy medium, rich in organic substances, situated on the shore of the Black Sea is described. A solution of NO_3La^{140} and $Na^{24}Cl$, of which the activity was about 50 mC was used to which inactive material was added. The choice of La and Na cations was determined by the absence of clayey material from the medium studied. The solution was introduced into a central well, and its passage through other neighboring wells, spaced at distances of 1 to 5 m, was detected using submersible Geiger-Müller counters. The operation was repeated in several places within the region studied. The activity to be used was calculated, taking into account the efficiency of the detection apparatus, the dimensions of the portions of ground studied, the estimated value of the flow velocity, the eventual absorption of the tracer by the ground, and the maximum permissible levels of the radioisotopes in water. (auth)

25534 DETERMINATION OF THE DISTRIBUTION OF SEWAGE CONCENTRATION IN LARGE NATURAL WATERS FROM PLANNED SEWAGE OUTLETS. O. Berg and E. Somer (Danish Isotope Centre, Copenhagen). p.405-14 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. I." Vienna, International Atomic Energy Agency, 1963.

The use of short-lived radioisotopes like Br^{82} and Na^{24} for the tracing of water-flow in large natural waters is well-established. The usual technique consists principally in a short-term injection of a radioactive solution at points of interest, and subsequent charting of the distribution of the activity at different time intervals after the injection. In this manner qualitative information about flow patterns, etc. can be obtained. The problem of determining suitable places for sewage-water outlets in the open sea at localities where the problem of the pollution of bathing beaches, fishing waters, etc. exists was studied. Since the difficulty consists in evaluating the concentrations of sewage-water at different points to be expected as a result of accumulation over a long period, the application of the ordinary short-term injection principle mentioned before seems unsatisfactory. However, they modified the evaluation of measurements, working on the assumption that a continuous injection is built up of an infinite number of identical short-term injections. The consequence of this assumption is that sufficient knowledge of the distribution of the activity from a single short-term injection at different periods after injection makes it possible, by integration of activity concentration with regard to time at every point of interest, to construct a single chart showing the stationary distribution of sewage concentration which would be obtained as a result of a continuous sewage outlet with known rate of flow. Errors and limitations of the method, which can usually be overcome under practical conditions, are described. The method found widespread use in Denmark, and investigations are now carried out on a routine basis with instruments that can be handled by a single semi-skilled technician. The boat which tows the detector in a zigzag line through the area of interest is fitted with a radionavigation instrument, a battery-driven transistorized logarithmic ratemeter, and a clock. Simultaneous readings of activity, position, and time are taken every 20 sec by means of an automatic 16-mm film camera. One day's measurements can be plotted and evaluated before the next day's measurements are started. (auth)

25535 PRODUCTION AND USE OF SHORT-LIVED RADIOISOTOPES FROM REACTORS. VOL. II. Proceedings of the Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors held at Vienna, November 5-9, 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. Mar. 1963. 281p. (STI/PUB/64(Vol.II))

Nineteen papers presented at the Seminar on the Practical Applications of Short-Lived Radioisotopes Produced in Small Research Reactors are given. Separate abstracts were prepared for 3 papers. Sixteen papers were previously abstracted for NSA. (M.C.G.)

25536 SOME TECHNIQUES FOR THE DETERMINATION OF ISOTOPES OF SHORT HALF-LIFE AS APPLIED TO THE ACTIVATION ANALYSIS OF BERYLLIUM. C. A. Baker (United Kingdom Atomic Energy Authority, London). p.39-44 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

It was necessary to analyze beryllium metal of high purity, prepared by distillation in a vacuum. The residual impurities are present at concentrations of a few parts per million and methods are described for determining

some elements at this concentration level by radioactivation analysis. In the cases of the elements discussed, the only active isotopes formed by thermal neutron activation have a short half life. Specific examples are given of such elements which can be determined by direct gamma spectrometry of the irradiated beryllium. Two examples of rapid chemical separations are also described where this is essential before the active isotope is counted, either because no gamma rays are emitted or because of a gross interference. (auth)

25537 SHORT-LIVED RADIOISOTOPES AND AUTORADIOGRAPHY OF FROZEN MATERIAL. R. Taugner and J. Iravani (Universität, Heidelberg). p.187-99 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

Autoradiography on frozen material was originally applied to the localization of soluble isotopes (and their compounds) in tissues. Three methods are available: freeze cutting, freeze drying, and freeze substitution. Each of these methods is subject to specific hazards: melting while cutting and the possibility of dehydration during processing and exposure (freeze cutting); dislocation and elution of the tracer during infiltration with the embedding medium and processing of slices (freeze drying); and also as a result of the necessary gradual dehydration and fixation (freeze substitution). Apart from the state of solubility of the tracer, for radioisotopes with short half-life, rapid processing is very important. Here autoradiography after freeze cutting was until recently the only method available and is therefore described in detail. In conclusion it is shown that the disadvantages listed above can be largely avoided by means of what may be called "freeze-grinding". Here the frozen tissue is first ground coarsely, then finely in liquid nitrogen and stored at −190°C. In this way very hard materials, e.g., bone-containing tissues, and also tissues with large water-containing compartments, can be radiographed quickly with a minimum of artefacts due to dislocation, and with satisfactory resolution. (auth)

25538 APPLICATIONS OF FLUORINE-18 IN BIOLOGICAL STUDIES WITH SPECIAL REFERENCE TO BONE AND THYROID PHYSIOLOGY. M. Anbar (Weizmann Inst. of Science, Rehovoth, Israel and IAEC Soreq Research Establishment, Rehovoth, Israel). p.227-45 of "Production and Use of Short-Lived Radioisotopes from Reactors. Vol. II." Vienna, International Atomic Energy Agency, 1963.

F^{18} was applied to a great variety of problems in biology and medicine. Methods were developed to prepare fluorine by each of the $O^{18}(p,n)$, $O^{16}(H^3,n)$ and $F^{19}(n,2n)$ reactions. Radiofluorine-labeled compounds were prepared by isotopic exchange, by synthesis, by recoil labeling, and by retention of fluorine in fluoro-organic compounds undergoing the (n,2n) reaction. Special low-level counting techniques were developed to cope with the low activities of tracer amounts of organic fluoro-compounds. F^{18} ions were applied to studies in bone physiology. It was found that F^- follows calcium in many aspects of its physiological behavior; the accumulation of F in bone was found to increase under the influence of vitamin D and of testosterone, whereas cortizone and estrogens diminished the extent of fluoride accretion. The pattern of distribution of fluorine in the organism was modified when administered in the form of a cationic complex. F^{18}-labeled YF^{2+} or ZF^{3+} were found to follow the pattern of distribution of the parent cations. Fluoroborate ions were shown to accumulate in the thyroid gland to an extent comparable to that of iodide ions. Fluoroborate ions do not undergo any organic binding in the thyroid, and their uptake is a specific indication of the function of the "trapping stage" in the gland. F^{18}-labeled fluoroborate was applied to a variety of problems in thyroid physiology. It was shown that TSH diminishes the uptake of BF_4^- in the first few hours after administration and enhances it after 24 hr. The inhibitory action of iron, copper, zinc, cadmium, fluoride, thiocyanate, and other ions on the iodine uptake was simulated by BF_4^-; thus the trapping stage was shown to be involved. In an analogous series of experiments, sulphydryl-containing compounds, as well as azide ions, were found to enhance the trapping of fluoroborate, although they diminished the overall iodine uptake. Next, it was demonstrated that the trapping stage is much less radiosensitive than the stages of thyroxine formation and release. A quite different application of F^{18}-labeled fluoroborate ions was in the localization of brain tumors, by directional coincidence scanning owing to the limited permeability of these ions via the intact blood-brain barrier. F^{18}-labeled fluoraromatic chelating agents were prepared and applied to problems in bone physiology. F^{18}-labeled aromatic vital dyes were used in investigating problems of permeability through biological membranes. F^{18}-labeled fluorine containing antimetabolites including 5-fluorouracyl and fluoro-orotic acid, was prepared and applied to physiological problems, including cancer research. (auth)

25539 NUCLEAR REACTOR LOOP FOR PARTICULATE RADIATION OUTSIDE CORE. Thomas A. Reiter (to Esso Research and Engineering Co.). U. S. Patent 3,092,560. June 4, 1963. Filed Dec. 30, 1958.

A process is given for irradiating gaseous or liquid chemical reactants with gamma and beta rays free from neutrons. The process comprises activating a fluidized bed of solids of high neutron absorption cross section in a reactor and flowing the solids to a chemical reaction zone outside the reactor. An example of the process is illustrated, in which centane vapors are converted into high viscosity index oil by irradiated indium oxide solids. (D.L.C.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

Refer also to abstracts 25860, 25867, 26082, and 26786.

25540 (BNL-6952) ANALOGUE MULTIPLICATION WITH FIELD-EFFECT TRANSISTORS. G. L. Miller and V. Radeka (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 17p.

The field-effect transistor is basically a variable conductance controlled by the reverse bias of the gate-channel junction. For signals small compared to the device saturation voltage, analogue multiplication based on proportionality of channel conductance to gate voltage is possible. The multiplication principle proposed has the advantages of high accuracy, speed, stability, and simplicity. A bridge circuit for four-quadrant pulse amplitude multiplication is described. The nonlinearity is less than 1%. The multiplication time was presently available devices is about 0.5 μsec at residual output of less than 1% and output dynamic range of 100. The bridge is inherently temperature compensated giving an operating range from −50°C to +80°C. (auth)

25541 (BNL-6953) FIELD-EFFECT TRANSISTORS IN CHARGE SENSITIVE AMPLIFIERS. V. Radeka (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 17p.

Field-effect transistors are investigated as low noise active devices for charge sensitive amplifiers. Noise sources, signal-to-noise relations, and charge sensitive amplifier circuits for field-effect transistors are considered. Measurements show an equivalent noise charge of 60 rms electrons per pF for low capacitance (3 pF) devices and 20 rms electrons per pF for high capacitance (30 pF) devices. Operation at low temperatures to −200°C is possible. (auth)

25542 (CEA-2266) ETUDE EXPERIMENTALE DE L'IMPEDANCE DES SOURCES D'IONS HAUTE FREQUENCE A DECHARGE LINEAIRE — MODIFICATIONS AU MODELE DE SOURCE DU TYPE "MOAK." (Experimental Study on the Impedance of Linear Discharge High Frequency Ion Sources. Modifications on the "MOAK" Type Source). Ch. Fremiot (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucleaires, Grenoble). [1962]. 51p.

Thesis submitted to Univ. of Grenoble, France.

A method of measuring the ion H. F. source impedance is described, and the influence of the working parameters on that impedance is studied. The origin of some working anomalies is deduced with a new coupling method. The gas flow is decreased by modifying the geometry of the discharge vessel. (auth)

25543 (CERN-63-10) A FILM ANALYSER. J. Richez (European Organization for Nuclear Research, Geneva). Mar. 27, 1963. 28p.

A scanning device for use as a film analyzer is described. The machine was originally developed to analyze oscilloscope pictures, but other types of pictures such as spark chamber pictures are proposed for analysis. The device differs from other scanning machines in that the cathode ray spot is obliged to follow the picture of the trace to be analyzed. One signal scan is sufficient to give complete information. (C.E.S.)

25544 (EUR-20.e) EXTENDED RANGE TRANSISTORIZED PRECISION RATEMETER. V. Mandl (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). Feb. 1962. 14p.

An improved linear ratemeter based on a saturated core blocking oscillator is described. The instrument has an input range from 10 to 10000 pps and is characterized by a better stability and linearity. The modifications introduced into the circuit are discussed and the measurements made are reported. (auth)

25545 (EUR-30.e) POWER SUPPLY FOR ESONE STANDARD PLUG-IN SYSTEM. I. De Lotto, G. Gianneli, and L. Stanchi (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1962. 28p.

A transistor power supply for two cases according to ESONE standard is described. It consists of a 24-v semiregulated voltage from which all the regulated voltages required by the standard are derived. The 24-v semiregulated voltage is obtained by controlling two switching transistors with magnetic amplifiers. The regulators use a new circuit and are protected against overloads and short circuits. The analysis of the circuits and the protection system is given. (auth)

25546 (ISS-63/21) SERVIZIO ELETTRONICO — CATALOGO DELLE APPARECCHIATURE ELETTRONICHE STANDARDIZZATE DE E 111 A E 120. (Electronic Service — Circuit Diagrams and Characteristics of Standard Electronic Equipments E 111 to E 120). (Italy Istituto Superiore di Santà, Rome). Jan. 31, 1963. 48p.

A catalog of circuit diagrams and characteristics of electronic equipment built by the electronic service of the Laboratory of Physics is presented. The main purpose of this catalog is to give to the experimenter a short account of on-the-shelf equipment available. The catalog will be printed in many issues each containing the data on ten pieces of equipment; an index of all issues will be periodically printed. Owing to the essentially practical purpose of this catalog, every specific technical and scientific news was omitted; bibliographic news will be added only in the case of new circuits. (auth)

25547 (LADC-5192) AN AUTOMATIC COMPARATOR FOR MEASUREMENT OF SPECTROGRAMS. David W. Steinhaus, Rolf Engleman, Jr., William L. Briscoe, Kenneth B. Mitchell, H. Milton Peek, and P. E. Rouse, Jr. (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 19p.

An automatic comparator is described that makes possible the separation of blended groups of lines and extensive line shape studies of high-resolution spectrograms. By using digital computers to reduce the comparator data, the subjectiveness and possibility of human error are avoided. The comparator has a continuously and uniformly rotating precision screw and digital readout of data. The readout is simply the plate transmission at equal intervals along the spectrum, and the interval is small compared to resolution. (C.E.S.)

25548 (MATT-162) A MONOCHROMATOR WAVELENGTH MODULATOR. Arthur F. Kuckes (Princeton Univ., N. J. Plasma Physics Lab.). Jan. 1963. Contract AT(30-1)-1238. 8p.

A technique for modulating the wavelength of a monochromator is described. By means of this modulation tech-

nique and a phase detection scheme, a method for obtaining the Doppler shift of spectral lines associated with movements of the source is presented. (C.E.S.)

25549 (NAA-SR-Memo-8145) REPORT OF THE QUALIFICATION TESTING OF SNAP 10A FIXED RESISTORS. J. S. Holtwick, III (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 23, 1963. Contract [AT(11-1)-Gen-8]. 31p.

Upon completion of the initial visual examination and dimensional check, the resistors were weighed and the weights were recorded. The measurement of insulation resistance, performed with a megohmmeter, indicated infinity for each resistor. The dielectric strength test was performed with a high potential a-c dielectric strength tester. The test voltage was applied with no evidence of leakage or breakdown in any case. A wheatstone bridge was used to measure the d-c resistance of each resistor. All the resistors were well within their specified tolerance. The resistance-temperature characteristic test was performed in a temperature chamber at –67 to 302°F. The resistance of each was measured with a wheatstone bridge at 9 temperatures. The resistors exhibited a negative temperature coefficient, but remained within allowable tolerances. Upon completion of vibration and shock, the d-c resistance, dielectric strength, and insulation resistance, each resistor was measured. There was no evidence of damage in any case. (auth)

25550 (NP-12803) 10 MC SCALER WITH PRINT-OUT FACILITIES. Note 61-4. F. Iselin (European Organization for Nuclear Research, Geneva). May 1961. 24p.

A 10-Mc scaler with 6 decades is described. The scaler is transistorized with 1242 coded indication for saving expensive decoders and because print-out will generally be used. For many scalers, a common decimal visual indication (Nixies) is provided showing the contents of any scaler by pushing a look button. One separate power supply can feed 4 scalers and has the same dimensions as a scaler (4 units high and $\frac{1}{4}$ of 19" panel width). It is possible to place 3 scalers and power supply in a panel width, or when many scalers are used, 4 scalers per row and group all power supplies together. A full rack can contain 30 scalers with power supplies. (auth)

25551 (NP-12870) FAST SCALER TYPE 3009 AND POWER SUPPLY TYPE 1015. (European Organization for Nuclear Research, Geneva). 1962. 39p.

Diagrams and photographs of a type-3009 fast scaler and a type-1015 power supply are presented. (M.C.G.)

25552 (SAN-1005) AN X-RAY DENSITOMETER FOR TRANSIENT STEAM VOID MEASUREMENT. V. E. Schrock and F. B. Selph (California. Univ., Berkeley. Inst. of Engineering Research). Mar. 1963. Contract AT(11-1)-34. 62p.

The design criteria, construction, and calibration of equipment and analysis of data are presented for a densitometer for the study of transient boiling that occurs on the surface of fuel elements in water-cooled and moderated reactors. Data are included only to the extent necessary to fulfill this objective. (P.C.H.)

25553 (TIM-682) DEVELOPMENT OF LIQUID METAL LEVEL SENSORS. Robert R. Holmes (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Sept. 29, 1961. Contract AT(30-1)-2789. 42p.

Evaluations of several liquid metal level measuring devices led to the selection of a resistance-type probe for both continuous and discrete level measurements. The device was fabricated from a section of two or four conductor, metal clad, swaged material. The continuous level probe is bent in to a J configuration, welded into the liquid metal containment vessel, and cap welded at one end. Tests on various configurations of the device have led to the development of a probe that has less than 0.5% shift in calibration for a 1200°F change in temperature, and less than a 1.0% shift in calibration after 500 hr at 1000°F. Tests have indicated that after a short time at room temperature complete wetting occurs, and with proper surface preparation errors due to this effect can be reduced to less than 2% after two minutes. The probes were successfully applied to several test rigs. For discrete (one point) level determination a straight (I shape) probe was designed. The device is capable of giving very accurate and reliable indications of liquid level at one point. (P.C.H.)

25554 (TRG-Report-516) A BASIC TRAINING SCHEME. PART III. CALIBRATION AND ADJUSTMENT OF ELECTRICAL RECORDERS: NOTES. R. A. Chapman (United Kingdom Atomic Energy Authority. Reactor Group, Dounreay, Caithness, Scotland). Mar. 21, 1963. 33p.

Notes to be used by an instructor in teaching the adjustment and calibration of electrical recorders are given. Model answers to questions arising in this part of the overall program of training in instrumentation are given. (D.C.W.)

25555 (TRG-Report-523) A BASIC TRAINING SCHEME. PART IV. USE OF ELECTRONIC TEST EQUIPMENT: PROJECTS. R. A. Chapman (United Kingdom Atomic Energy Authority. Reactor Group, Dounreay, Caithness, Scotland). Mar. 28, 1963. 71p.

Projects forming part of a course to train apprentices as instrument mechanics are given. The use of general equipment used in testing electronic units is covered, and an introduction to components commonly used is provided. The characteristics and basic applications of thermionic valves are investigated, and the operation of the cathode ray oscilloscope is carefully introduced. The valve voltmeter is used, and a simple test oscillator is employed. The latter projects cover the characteristics and basic applications of semiconductor devices with a brief introduction to relaxation oscillators. (auth)

25556 (TRG-Report-524) A BASIC TRAINING SCHEME. PART IV. USE OF ELECTRONIC TEST EQUIPMENT: NOTES. R. A. Chapman (United Kingdom Atomic Energy Authority. Reactor Group, Dounreay, Caithness, Scotland). Mar. 29, 1963. 52p.

Notes to be used by the instructor of a course of basic, training in the primary features of instrumentation are given. The notes cover safety, craft, and theory and include model answers to problems associated with the segment of the course on the use of electronic test equipment. (D.C.W.)

25557 (Y-KH-19) CALCULATION OF INSPECTION DATA FOR RADIAL TYPE MEASURING MACHINES. C. W. Wilson and A. H. Fowler (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Oct. 11, 1962. Contract W-7405-eng-26. 19p.

A rotary contour thickness gage is described. The machine operates with polar coordinate reference axes rather than the usual cartesian axes. The method presented is basically that of rolling a ball along the defined curve until the center of the ball lies on a specified radial line. Com-

puter programs applicable to the machine are listed. (C.E.S.)

25558 NUCLEAR INSTRUMENTATION. NO. 14. Bull. Inform. Sci. Tech. (Paris), No. 67, Suppl., 1-43(Dec. 1962). (In French)

The characteristics of a fast coincidence circuit under actual operating conditions in the transitory regime were experimentally determined, and the results obtained are discussed. The construction and characteristics of a shielded cell for highly sensitive γ spectrography, one-way d-c amplifiers, automatic sample carrier, differential collector of total fall-out, tritium contamination detectors, α-β contamination monitor, radon detector, differential conductometer, mass spectrometer, and a fast pulse generator are given. (J.S.R.)

25559 NUCLEAR INSTRUMENTATION. NO. 15. Bull. Inform. Sci. Tech. (Paris), No. 68, Suppl., 1-49(Jan. 1963). (In French)

Because of the importance attached to the normalization of test measurements from an industrial point of view, three standardized test programs used by the CEA are reported. The three programs described are for stabilized power supplies, proportional pulse analyzers, and single-channel amplitude selectors. (J.S.R.)

25560 A COLLECTOR SYSTEM FOR ETL MASS SEPARATOR. Isao Kohno. Denki Shikensho Iho, 26: 773-6 (1962). (In Japanese)

The collector system for the ETL mass separator was improved for use with various collection methods, such as the box collection method, retarding collecting method and direct collection method. An ion beam monitor was devised for the continuous supervision of the shape and position of the image in the focusing plane of the mass separator. In the monitor a thin needle is subjected to vibrations of 20 c/s and of 7-cm amplitude through the fixed beams, and a pattern of the extension of the beams in the horizontal direction is obtained on an oscilloscope screen. A detailed description of this system and some preliminary experiments on it are given. (auth)

25561 TAKING HUMAN ERROR OUT OF NUCLEAR EXPERIMENTS. Ronald Pecina and Thomas Evans (Argonne National Lab., Ill.). Electronics, 36: 46-8(June 14, 1963). (TID-18593)

A programmable preset timer is described for the automatic operation of an experiment of several runs with set-up and active times. The timer includes a multiple preset six-decade counter with binary coded decimal outputs and a seven-level paper-tape reader-programmer. (D.L.C.)

25562 GRAIN COUNT CORRECTIONS IN AUTORADIOGRAPHY. J. Stillstroem (Uppsala Univ.). Intern. J. Appl. Radiation Isotopes, 14: 113-18(Mar. 1963). (In English)

Formulas are presented for calculating the true proportion of labeled cells and their mean grain count and grain count distribution in autoradiograms. Test and control material of the same kind are used. The procedure entails the inclusion of all cells labeled with one grain or more and thus excludes discrimination against cells with a low grain count. An analysis of the applicability of the formulas shows that they ought to be used in most labeling situations. They are unnecessary only in cases where test labeling is unusually high or control labeling unusually low. (auth)

25563 DEVELOPMENT OF A SCANNING MICROSCOPE—X-RAY LOCALIZED MICROANALYZER AND SOME OF ITS APPLICATIONS. Yu. M. Kushnir, D. V. Fetisov, K. K. Raspletin, B. I. Pochtarev, F. U. Spektor, R. P. Gurova, P. D. Tokarev, V. N. Osipov, and V. A. Pavlov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 415-19(Mar. 1963). (In Russian)

The development of a scanning electron microscope, an x-ray microanalyzer, is described. Data are presented on the use of this apparatus for the investigation of metals, minerals, and semiconductors. The electron probe consists of an electron gun with two electrostatically symmetrical lenses. The emitted x rays are examined by a spectrometer which utilizes the following planes of a quartz crystal, $(13\bar{4}0)$ and $(10\bar{1}0)$. The spectrometer is used in the range of Bragg angles 15 to 45° and analyses can be performed for x rays belonging to elements from magnesium to uranium. Improvements of the apparatus are described. These are directed toward increasing and bettering the electro-optical parameters of the system. Microphotographs, taken with this apparatus, are shown of the following materials: a copper electrolytic net, a mica mineral containing a large amount of chromspinellide crystals, a silicon semiconductor in which the p–n junctions can be seen, a germanium semiconductor, and a sample of recrystallized nickel. Work is continuing on the development of an apparatus with magnetic optics which is designed to improve the resolution of the system. (TTT)

25564 COMMERCIAL APPARATUS FOR X-RAY SPECTRAL ANALYSIS, MAR-1. M. M. Il'in, A. M. Solov'ev, V. N. Vertsner, G. G. Dutov, B. S. Kolchev, and S. A. Toporkov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 420-6(Mar. 1963). (In Russian)

A commercial apparatus to be used for x-ray spectral microanalysis is described. The apparatus consists of two basic components, the microanalyzer itself and the recording facility. The microanalyzer is made up of the following parts: an electron-optical system, an electron probe generator, an x-ray spectrometer, a sample chamber with an optical microscope, and a vacuum system. A three-electrode gun serves as the source of electrons with the following available accelerating voltages, 10, 15, 25, 35, and 50 kilovolts. The electron source cathode lasts about 60 hours and can be changed in approximately 15 minutes. The position of the sample can be changed, without breaking vacuum, in two mutually perpendicular directions. The optical microscope serves to control the shape and size of the electron probe, and to study the surface of the sample. Two spectrometers are available, one, situated in vacuum, is used to study radiation whose wavelength varies from 1.5 to 10 Å, the other, situated in air, is used for x rays up to 1.5 Å in wavelength. The system can be pumped down to operating conditions in about 2 or 3 minutes. Some results are presented concerning the detection of copper in two samples containing 0.5% and 0.26% copper. (TTT)

25565 A DUAL CHANNEL X-RAY MICROANALYZER. S. A. Ditsman and V. G. Bogdanov (Baikov Inst. of Metallurgy, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 427-9 (Mar. 1963). (In Russian)

The construction of a dual-channel x-ray microanalyzer is described. Two x-ray spectrographs with linearly movable crystals are used. It is hoped to use this apparatus in the investigation of fine structure in x-ray emission spectra. One of the spectrographs is situated in vacuum and is intended for use in the observation of radiation in the band of Bragg angles 25 to 45° (from 1.8 to 6 Å and 8 to 14 Å using reflections from the quartz crystal planes $\{10\bar{1}0\}$ and $\{100\}$, respectively). The other spectrograph is not situated in vacuum and encompasses Bragg angles from 25 to 60° (from 1 to 2 Å using the quartz crystal plane $\{13\bar{4}0\}$). The

radiation reflected from the crystals is detected in the vacuum spectrograph by a Geiger counter, and by a scintillation crystal in the non-vacuum system. The speed with which the object is moved can be varied from 1 micron/min to 250 microns/min. (TTT)

25566 DETECTION OF SINGLE SLOW IONS: A METHOD OF PRESSURE MEASUREMENT. L. Jacob (Royal Coll. of Science and Tech., Glasgow). Nature, 198: 774-5(May 25, 1963).

A gas-contaminated point in a demountable type of field emission microscope was adapted for use in the detection of single slow ions observed during electron microscopy. (C.H.)

25567 A DIGITAL LINEAR RATEMETER. C. H. Vincent and J. B. Rowles (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Instr. Methods, 22: 201-20(Apr. 1963). (In English)

A new type of linear ratemeter is described. This has an action similar to that of the ordinary diode-pump type, but the process is purely digital and the reading is displayed in binary form on a set of lamps. This ratemeter has many advantages, including complete freedom from saturation error and a very small calibration error, as the rates measured are relative to the frequency of an internal crystal-controlled oscillator. A meter display may be provided by conversion, if required. The instrument can be made very flexible, giving any speed required in binary steps over a wide range, with nearly the maximum accuracy statistically possible for random input pulses. While the circuits are more complicated than those of the ordinary linear ratemeter, they are mainly repetitive and are very suitable for construction by modern techniques for semiconductor components. Corrected for dead-time, the reading of the unit built is accurate to 0.1% to well over 10^5 cps. (auth)

25568 MODERN MULTI-CHANNEL TIME ANALYZERS IN THE NANOSECOND RANGE. M. Bonitz (Technische Universität, Dresden). Nucl. Instr. Methods, 22: 238-52 (Apr. 1963). (In English)

Comparison is made between single-channel time analyzers (method of delayed coincidences) and the multichannel time analyzers (method of time conversion) and the differences noted. Further a classification of electronic time converters is offered in accordance with the three principles of operation primarily used, viz. start-stop principle, vernier principle, and the pulse-overlap principle. (auth)

25569 A NANOSECOND LIGHT-PULSE GENERATOR USING A DISCHARGE LAMP. K. Nygaard and S. Malmskog (AB Atomenergi, Studsvik, Tystberga, Sweden). Nucl. Instr. Methods, 22: 363-4(Apr. 1963). (In English)

A simple spark generator was built for producing simultaneously a light pulse and an electrical trigger pulse. The generator comprises a small, 0.1-mm spark gap of 2 Pt spheres on W wire mounted in a glass bulb filled with Ar or 90% N_2 + 10% H_2 at 700 mm Hg. The frequency of the sparks and the pulse form are dependent on the resistor, capacitor, and high tension. (D.L.C.)

25570 A NUCLEAR MAGNETIC RESONANCE ABSORPTION SPECTROMETER FOR THE STUDY OF SOLIDS. S. Visweswaramurthy (Indian Inst. of Science, Bangalore). Nucl. Instr. Methods, 22: 375-6(Apr. 1963). (In English)

A spectrometer is described which solves the problem of large r-f amplification. A stabilized crystal oscillator is used, and its output is divided into two halves, one of which is fed into the sample coil in the grid circuit of a cathode follower, while the other half goes to a dummy coil in another cathode follower circuit. The two cathode follower outputs are fed to the first stage of r-f amplifier, whereby the carrier level is reduced to a very low value, thus allowing for succeeding large amplification while canceling out the noise. (D.L.C.)

25571 ON CERTAIN FEATURES IN ION FOCUSING OF ELECTRON BEAMS. L. E. Bakhrakh, Yu. I. Denisov, and S. I. Kiryashkin. Radiotekhn. i Elektron., 7: 1169-74(1962). (In Russian)

Experimental studies were made of a curving effect observed in electron beam focusing. Conditions producing curved electron beams were investigated as functions of gas concentration and current geometry. The possibility of producing focused beams along a 360 degree arc is discussed. Certain features of the phenomenon are also discussed. (tr-auth)

25572 ON THE QUALITY OF AMPLIFIER CASCADES AND OUTPUT CIRCUIT IN A WIDEBAND KLYSTRON. A. D. Vlasov and N. E. Belov. Radiotekhn. i Elektron., 7: 1787-94(Oct. 1962). (In Russian)

An analysis is made of the performance of a wideband klystron developed by resonance frequency distribution and by a simultaneously increased number of amplifying cascades forming a grouping or excitation section. Amplifying cascades and the output circuit of the wideband klystron are examined as functions of electron flow and resonator parameters. (tr-auth)

25573 STUDIES OF MODULATION RESPONSES OF SUPER-HIGH GAS DISCHARGE ATTENUATORS. E. A. Stakhov. Radiotekhn. i Elektron., 7: 2007-12(Dec. 1962). (In Russian)

Modulation responses of super-high frequency gas discharge attenuators operating without external magnetic field were investigated. It is shown that plasma interactions with super-high frequency fields can be used in the construction of high-quality modulation equipment of several hundred kc without danger of overloading. (R.V.J.)

25574 HOT-CATHODE MAGNETRON IONIZATION GAUGE WITH AN ELECTRON MULTIPLIER ION DETECTOR FOR THE MEASUREMENT OF EXTREME ULTRA-HIGH VACUA. J. M. Lafferty (General Electric Research Lab., Schenectady, N. Y.). Rev. Sci. Instr., 34: 467-76(May 1963).

A hot-cathode magnetron ionization gage capable of measuring pressures as low as 10^{-14} Torr has been described in previous publications. The low-pressure limit of this gage is extended by the addition of an electron multiplier ion detector. The ions generated in the magnetron gage are focused onto the first dynode of the multiplier by an electrostatic lens system. The multiplier gain is high enough to permit the use of an ion counting technique for the measurement of very low pressures. The lens system focuses the ions from the gage into a beam that passes through two limiting apertures before striking the first dynode. This arrangement prevents the soft x rays generated at the magnetron gage anode from falling directly on the first dynode. The x-ray photoemission from the first dynode is reduced by a factor of 50,000 below that observed for the magnetron gage alone. Measurements of sensitivity and x-ray photocurrent indicate that this device should have a linear response down to pressures of 2×10^{-17} Torr. Ability to measure low pressures with the gage appears to be limited by the inherent dark current of the multiplier. The gage may be used to advantage for the measurement of higher pressures by operating at reduced

emission current levels to minimize pumping and degassing effects. Photoemission from the first dynode caused by incident light from the magnetron gage filament has been reduced to values below the x-ray photoemission by the use of a lanthanum hexaboride cathode which operates at only 675°C. This low operating temperature reduces the problem of gas reactions with the filament. Radiation from gas molecules excited by electron impact in the magnetron gage was observed in the 10^{-9} Torr pressure range. (auth)

25575 TRANSISTORIZED AUTOMATIC DATA RECORDING FOR COSMIC-RAY DETECTORS. K. F. Richard, U. R. Rao, and W. B. Smith (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr., 34: 504-9(May 1963). (TID-17960)

A transistorized automatic data recording system was developed to provide more reliable instrumentation for the cosmic-ray physicist. The system includes a counting rate integrator, a memory circuit, an electronic clock, and a serial-to-decimal converter. Besides reliability, small size, and low power consumption, the system can give both BCD and decimal output which are automatically punched on IBM cards. (auth)

25576 VACUUM TECHNIQUES IN MASS SPECTROMETRY EMPLOYING TITANIUM PUMPS. D. Charles and J. Vastel (TSF, Orsay, France). Vide, 18: 185-8(Mar.-Apr. 1963). (In French)

Vacuum techniques in mass spectrometry are discussed. A description is given of an original demountable vacuum seal with a teflon gasket, a cold trap, a leak, and a stopcock, all bakable. The pumping of a mass spectrometer with titanium-ion pumps was studied on residual spectrum and on isotopic ratio determination of CO_2 and UF_6. The low helium pumping speed of titanium pumps was applied to show it is possible to detect as low as 2.10^{-3} ppm of helium in a mixture. (auth)

25577 CONTAMINATION OF SPUTTER-ION PUMPS. A. E. Barrington and A. B. Francis (Varian Associates, Palo Alto, Calif.). Vide, 18: 189-97(Mar.-Apr. 1963). (In English and French)

Sputter-ion pumps were used in increasing numbers in numerous applications, ranging from miniature appendage pumps on microwave tubes to major installations on space environment simulation chambers, particle accelerators, and fusion machines. This extensive operating experience led to the recognition and identification of phenomena which may adversely affect the starting and pump-down characteristics of sputter-ion pumps. It was found that these can usually be ascribed to contamination by water vapor or heavy hydrocarbons. Thermal release of hydrogen can also lead to slow starting. Other factors which contribute to the starting problem include low pumping speed at pressures above 10^{-3} torr, pump heating and the "power hill", discharge cleaning of the pump and system surfaces, and the accumulation of spongy deposits inside the pump. Slow starting was alleviated by such remedies as letting the system up to an atmosphere of dry nitrogen rather than room air and providing adequate foreline conductance and pumping speed. Rejuvenation methods include air baking, chemical cleaning, and complete replacement of pump elements. Although discharge cleaning of surfaces can delay starting, it was found to be beneficial in increasing the pump-down rate at pressures below 10^{-6} torr and thus shortening the overall pump-down period. Baking of pump and system at moderate temperatures accelerated pump-down. This is shown for a typical system designed for a base pressure of 10^{-9} torr. (auth)

25578 A PUNCHED TAPE CONTROLLED X-RAY DIFFRACTOMETER FOR AUTOMATIC MEASUREMENT OF DIFFRACTION INTENSITIES OF SINGLE CRYSTALS. E. W. Berkl. Thesis, Munich, Technische Hochschule, 1961. 77p. $2.00.

The design and performance of an x-ray diffractometer using punched tape to control the diffraction angle are described. Measurements of reflection in a reciprocal hemisphere are possible. The results of the measurements are punched on paper tape and can be used directly as input data for an electronic computer. (Gmelin Inst.)

25579 A NEW VELOCITY SELECTOR FOR MOLECULAR BEAMS. Arthur Edward Grosser. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 223p.

A new molecular beam velocity selector was constructed and successfully tested with atomic beams of cesium and rubidium. The velocity selector used a geometry calculated to provide: unique advantages for beam-beam scattering experiments, a short path length through the selector, and some simplicity in machining the selector. This design consists of a disc, 7.42 in. in diameter, with a 3.08 in. diameter central hole. The inner and outer radii are connected by spiral slots of small curvature. The disc was fabricated from glass and the spiral-containing plate was sandwiched between two solid glass discs. The disc rotates about a central axis perpendicular to its face and the molecular beam may originate at either the inner or the outer rim. The velocity selector is driven by an induction motor stator located outside the vacuum system. The advantage of this velocity selector lies in the ease with which certain atomic beam scattering experiments may be performed. If two velocity selected atomic beams are to intersect for a scattering experiment, full scattering intensity will be realized only if the modulation frequencies of the beams are the same, and if the beams are in phase. These problems are simplified by velocity selecting both beams with the same selector. Ovens located at the outer rim will have their monoenergetic beams intersect at the center of the disc. A detector may sweep about the inner rim of the disc to determine the scattering pattern. Such a situation reduces drastically the problem of phasing two beams together since the modulation frequency is the same. Because the two beams possess the same velocity, the mass or the incident angle of intersection is varied to obtain different relative collision energies. (Dissertation Abstr. 23: May 1963)

25580 COMPOSITION INSENSITIVE BETA RAY GAUGING SYSTEM. John R. Dukes and Denman K. Allemang (to Industrial Nucleonics Corp.). U. S. Patent 3,087,061. Apr. 23, 1963. Filed Apr. 14, 1960.

A β-ray gage for measuring the thickness of a material is patented. The gage is made insensitive to variations in composition or atomic number by measuring both the transmitted β rays and the x rays generated in the material by the β rays. The relative magnitudes of the signals from the x rays and the β rays can be adjusted so that the decrease in β transmission due to an increase in effective atomic number is canceled by the increase in x-ray generation. The physical principles of β transmission are reviewed, and the design of the gage is described. (M.P.G.)

25581 TRACE GAS ANALYZER. William C. Pfefferel (to Engelhard Industries, Inc.). U. S. Patent 3,087,112. Apr. 23, 1963. Filed Dec. 30, 1959.

A gas analyzing system is patented, which has a sensitivity of better than one part per million. The gas to be detected is combined with a purified carrier gas such as

H or He. A plurality of chromatographic separation columns may be used followed by a tetrode secondary-ionization electron-tube detector. The carrier gas must have a higher ionization potential than the gas to be detected, and the potential between the cathode and accelerating grid of the detector must be slightly less than the ionization potential of the carrier gas. The gas to be detected is ionized, and the positive ions are drawn toward the plate. The high negative potential between the screen grid and the plate permits secondary ionization of the carrier gas, which provides considerable amplification within the tube. The design of the system as a whole and alternative designs are described in detail. (M.P.G.)

25582 DETECTOR FOR GAS CHROMATOGRAPHY. Richard A. Foster (to Beckmann Instruments, Inc.). U. S. Patent 3,087,113. Apr. 23, 1963. Filed Jan. 23, 1961.

An ionization detector for a gas chromatograph is patented, in which the detector housing, the high-voltage power supply, and the output amplifier may be operated at circuit ground. The background current is not connected to the output circuit, and therefore does not need to be bucked out in the measuring system. The electron-collector electrode is operated at a relatively high potential with respect to circuit ground and is separated from the ion-collector electrode by a grid maintained at approximately circuit ground. The operation of the detector and details of construction are detailed. (M.P.G.)

25583 PARTICLE COUNTING APPARATUS. Donald Sydner Hobbs (to North American Phillips Co., Inc.). U. S. Patent 3,088,036. Apr. 30, 1963. Priority date May 17, 1957, Great Britain.

A particle-counting apparatus is patented, which provides sizing counts (number of particles in each size group) of the particles in sample. The particle sample is scanned in a series of parallel lines by a flying-spot scanner scch as a cathode-ray tube. Electrical signals are produced by a photoelectric cell corresponding to interceptions of the flying spot by the particles. A memory system enables the counting apparatus to disregard all but one interception by a large particle overlapping two or more lines. Sizing counts are provided by circuits, which compare the duration of interceptions with a predetermined time interval and route a count signal to a counter when the signal duration is greater than the time interval. The operation of the circuits is described in detail. (M.P.G.)

25584 MASS DISTRIBUTION ANALYZER. George B. Foster (to Industrial Nucleonics Corp.). U. S. Patent 3,092,724. June 4, 1963. Filed July 27, 1959.

A method and an instrument are described for measuring the relative uniformity of mass distribution in a material, e.g., filters, textiles, etc. The method comprises irradiating the material with two radiations of different energies, detecting the transmitted radiations, and generating a signal representative of the ratio of the transmitted radiations and indicating the uniformity of the mass distribution. (D.L.C.)

Radiation Detection

Refer also to abstracts 24761, 24776, 25858, 26038, 26041, 26084, 26086, 26198, 26199, 26201, 26211, 26221, 26236, 26459, and 26787.

25585 (AFSWC-TDR-63-19) DESIGN AND FABRICATION OF RADIATION DOSIMETRY INSTRUMENTS FOR TISSUE EQUIVALENT PLASTIC MANIKINS. Final Report. Kay M. Hoalst (Hughes Research Labs. Div. of Hughes Aircraft Co., Malibu, Calif.). Apr. 1963. Contract AF29(601)-4607. 50p.

An instrumentation system to measure the absorbed dose due to ionizing radiations was designed for use with a tissue-equivalent manikin in space flights. The ionization chambers are fabricated from tissue-equivalent materials to match those of the manikin and conform in design to the Bragg-Gray principle. Experimental curves show saturation conditions, pressure extrapolations, and directional dependence. The design has minimized directional dependence with average losses ranging from 5 to 20 percent due to shielding of the first-stage electronics, which have been incorporated directly with the ionization chamber. The electrical signal generated by the radiation absorbed dose rate as recorded by the chambers is then processed electronically and telemetered back to earth. The electronic instrumentation functions continuously over a dose range of 0.01 to 100 rads per hour and has a logarithmic response. The chambers are designed to be placed in the tissue-equivalent manikin at the following sites: femur, abdomen, mediastinum, humeri, and spinal column. Automatic calibration is provided for in both the femur and abdomen electronics. The calibration data were obtained by using the gamma rays emitted by cobalt-60. (auth)

25586 (ANL-6646) RADIOLOGICAL PHYSICS DIVISION SEMIANNUAL REPORT, JANUARY THROUGH JUNE 1962. (Argonne National Lab., Ill.). Feb. 1963. Contract W-31-109-eng-38. 174p.

Separate abstracts were prepared on 11 sections of this report. Abstracts of 5 sections have previously appeared in NSA. (C.H.)

25587 (ANL-6646(p.5-29)) THEORY OF ALKALINE EARTH METABOLISM. THE POWER FUNCTION MAKES POSSIBLE A SIMPLE BUT COMPREHENSIVE MODEL OF SKELETAL SYSTEMS. John H. Marshall (Argonne National Lab., Ill.).

A simple way was found to incorporate the power function, so useful in describing the retention of radioactive bone-seekers, into a metabolic model which agrees surprisingly well with data for the behavior of radioisotopes of calcium, strontium, barium, and radium in dog and in man. The power function is a mathematical expression in which the independent variable (time) is raised to a constant power (usually not an integer). Although it has been considered merely an empirical device for approximating data, the power function may have a deeper significance in the evolution of complex systems. The behavior of the model can be completely determined by a set of three parameters. One such set is the excretion rate, the accretion rate, and the one-day retention of a radioisotope. The model can approximate the activity per gram of calcium both in the blood and in the body as a whole from minutes to years following either an intravenous injection or continuous feeding. The mathematics are applicable not only to adult but also to growing skeletal systems. Simple expressions relate the metabolic parameters to the parameters of the power function and to the turnover rate derived from data on Sr^{90} in man due to fallout. Thus, two divergent groups of measurements of the average turnover time of the adult human skeleton can be reconciled by a single model. Under certain conditions, one can predict the time required for a radioisotope to reach equilibrium within the body, the time after which retention must follow an exponential rather than a power function. Though its

predictions are sometimes only rough approximations to biological data, the model strikes a useful compromise between accuracy and simplicity, thus providing a convenient means for interrelating existing experiments and suggesting new ones. (auth)

25588 (ANL-6646(p.30-1)) DECAY-TIME APPARATUS. O. J. Steingraber and I. B. Berlman (Argonne National Lab., Ill.).

Design features are described of an apparatus to measure the decay time of organic scintillation crystals, plastics, and solutions. A special feature of the system is its ability to accept pulses random in time and amplitude, and, therefore, excitation of the scintillation material can be obtained from either α particles, β particles, or ultraviolet radiation. (C.H.)

25589 (ANL-6646(p.34-41)) A MEASUREMENT OF THE PHOTOLUMINESCENT QUANTUM YIELD OF LIQUID SCINTILLATORS. A Preliminary Report. W. R. Anderson and I. B. Berlman (Argonne National Lab., Ill.).

An investigation was made of two methods for the measurement of the photoluminescent quantum yield of liquid scintillators. One method involves the use of an integrating sphere and the other involves an analysis of the degree of polarization of the radiation of both the scatterer and the fluorescent solution in the direction of the detector. The apparatuses and methods are described and preliminary results are discussed. (C.H.)

25590 (ANL-6646(p.44-9)) STUDIES OF LOW ACTIVITY PHOTOTUBE MATERIALS. H. A. May and P. E. Hess (Argonne National Lab., Ill.).

A study was made of low-activity phototube materials and components. Data are tabulated on the radioactivities of some materials involved in such construction. The development of specialized ceramics for use in vacuum tubes capable of extremely high-power output at frequencies of 10 kmc and above is discussed. (C.H.)

25591 (ANL-6646(p.50-65)) NEUTRON PRODUCTION IN MASSIVE SHIELDS AND EFFECT UPON THE LOW-ENERGY GAMMA-RAY BACKGROUND. H. A. May (Argonne National Lab., Ill.).

Examination of results from experiments designed to elucidate the contribution of cosmic ray phenomena to the background of low-energy γ rays observed in large NaI crystals inside massive shields led to the conclusion that locally-produced neutrons are present in significant numbers. Processes capable of generating evaporation neutrons were examined for the origin of these neutrons. A summary is presented of cosmic ray and neutron physics appropriate to an understanding of low-energy γ ray production in a similar environment. (C.H.)

25592 (ANL-6646(p.66-7)) OBSERVATION OF BACKGROUND IN A LARGE WATER SHIELD. H. A. May (Argonne National Lab., Ill.).

Measurements were made of the low-energy background in a water-shielded human whole-body counting room. Results are compared with data from an iron-shielded and lead-lined similar room. (C.H.)

25593 (ANL-6646(p.68-77)) EFFECT OF SILVER HALIDE CONTENT ON THE FILM DOSIMETRY OF A $Sr^{90}-Y^{90}$ APPLICATOR. Amrik S. Chhabra (Argonne National Lab., Ill.).

Different dilutions of G5 Ilford emulsion were used in Lucite for depth dose measurement of radiations emitted by a $Sr^{90}-Y^{90}$ β-ray applicator and compared to results obtained with a Failla extrapolation chamber. The response of emulsion with normal silver content is quite satisfactory in the β-ray region, but it is too sensitive in the bremsstrahlung region by a factor of $\approx$40. The response of emulsions in which the AgBr:gelatin ratio is decreased by as much as a factor of five approaches somewhat that of the ionization chamber, in fair agreement with calculations based on Greening's formulation, but it is still too high for accurate dose measurements in regions where the contribution from bremsstrahlung is of the order of a few percent. Values of 2250 and 460 ev were found for the energy required to produce a developable grain. (auth)

25594 (ANL-6646(p.78-91)) EFFECT OF LONG DECAY CHAINS ON THE COUNTING STATISTICS IN THE ANALYSIS OF RADIUM^{224} AND RADON^{222}. H. F. Lucas, Jr., and D. A. Woodward (Argonne National Lab., Ill.).

In the counting of long decay chains, it is often necessary to use counting intervals that are long with respect to the half-life of the individual members of the series. With modern instrumentation the efficiency may be very nearly 100%. Consequently, the approximations normally used for estimating the statistical counting error are not valid. A method is presented by which the variance of the observed count can be easily calculated for any long decay chain. The effects of the counting interval, the efficiency, and the delay of start of counting relative to the time of separation of Ra^{224} and Rn^{222} from their respective daughters are presented. The counting interval and the efficiency were found to produce significant effects for both the Ra^{224} and the Rn^{222} series. A simple and convenient method is presented to correct for this effect by the use of a quantity J which can be calculated for a given experimental condition. (auth)

25595 (ANL-6646(p.110-12)) PERIODIC EVENTS IN BONE. D. J. Simmons (Argonne National Lab., Ill.).

Periodic events in bone metabolism were investigated in rats using Sr^{85} as a tracer. Data are tabulated on the retention of Sr^{85} in serum and bone at various times after administration. (C.H.)

25596 (ANL-6646(p.113-5)) THE RETENTION OF Ba^{133} IN BEAGLES. R. E. Rowland (Argonne National Lab., Ill.).

Whole-body measurements of Ba^{133} retention in dogs were made for 1,000 days after injection. The plasma specific activity was a factor of 50 below that of the skeleton after 1,000 days. (C.H.)

25597 (ANL-6646(p.151-68)) THE EFFECTS OF ATMOSPHERIC STABILITY AND HORIZONTAL SHEAR ON THE ACCUMULATION AND DIFFUSION OF RADON. John E. Pearson and Harry Moses (Argonne National Lab., Ill.).

Studies of the vertical and temporal distributions of natural atmospheric radon resulted in new data on the natural radioactivity of the atmosphere and in an increased interest in the possibility of using radon data to indicate the behavior of materials released to the atmosphere from a ground area source. Results are reported from a series of tests in conjunction with accurate measurements of wind and temperature profiles. (auth)

25598 (ISS-63/20) RIVELATORI A STATO SOLIDO (RASSEGNA). (Solid State Detectors (A Review)). L. Maiani (Italy. Istituto Superiore di Sanità, Rome). Jan. 31, 1963. 31p.

The properties and possibilities of solid state detectors are discussed. Their performance in heavy charged particle spectrometry is discussed, and their limitations, especially their small sensitive volume which severely limits their application not only in γ spectrometry but also

in high-energy physics, are noted. The amplifier noise is also considered, and the characteristics and performances of various presently available solid-state detectors are set out. (auth)

25599 (PAN-377/I-B,IX) KRZEMOWE DETEKTORY NEUTRONOW TERMICZNYCH. (The Silicon Detectors of Thermal Neutrons). Ya. Khvashchevska and A. Shekther (Polish Academy of Sciences, Inst. of Nuclear Research, Warsaw). 1963. 13p.

Surface barrier detectors for charged heavy particles were used for detection of thermal neutrons by covering them with a layer of boron, lithium, and uranium. The acting area of the detectors was from 10 to 500 mm^2. The resistivity of silicon used for these detectors was 265 and 1000 ohm-cm. Efficiency and some of their characteristics were measured. (auth)

25600 (PAN-380/VI) PARTICLE IDENTIFICATION IN THE HYDROGEN BUBBLE CHAMBER. Jerzy Bartke and Andrzej Eskreys (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1962. 9p.

Measurements of ionization and momentum were done on 60 positive tracks from 16 eight- and ten-prong stars, produced by 10 Bev/c negative pions in the 80-cm hydrogen bubble chamber. The ionization was found by means of the mean gap length method, which gives the typical error in ionization value of about 10%, as calculated from O'Ceallaigh's formula. This gives the possibility of distinguishing between pions and protons up to 1.7 Bev/c momentum and between pions and kaons up to 0.9 Bev/c momentum. The ionization measurements on about 60 beam tracks show however, that the error should be cut down by a factor of 1.5 to 2.0, which allows changing the above-mentioned limits for pions-protons distinction to 2.0 Bev/c and for pions-kaons to 1.1 Bev/c. (auth)

25601 (PAN-408/IX) ABSOLUTE THERMAL NEUTRON DENSITY MEASUREMENTS BY THE ACTIVATION METHOD USING LIQUID SCINTILLATORS. Edward T. Józefowicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 14p.

Details of a method of absolute beta activity measurements by dissolving the active sample in liquid scintillator and extrapolating the bias curves to zero discrimination are worked out. This method was used for absolute thermal neutron density measurements by an activation method using five nuclides: phosphorus, sodium, iodine, manganese, and indium. For all these elements suitable chemical compounds soluble in the liquid scintillator were chosen and the whole chemical procedure was developed. In favorable conditions densities in the range 10^{-2} to 10^{9} n/ccm can be measured with an accuracy of 4%. (auth)

25602 (PAN-411/IX) A SURVEY OF THE DETECTORS DEVELOPED IN THE REACTOR ENGINEERING DEPARTMENT OF THE INSTITUTE OF NUCLEAR RESEARCH IN SWIERK. Wacław Dabek, Jadwiga Jabłońska, Andrzej Janikowski, and Jerzy Topa (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 34p.

Some types of radiation detectors developed for reactor control system and reactor physics experiments are described. They include: neutron sensitive ionization chambers/gamma-compensated and without compensation/, pulse fission chambers, miniature fission chambers and gamma sensitive ionization chambers for neutron flux and gamma distribution measurements, and a 4π gamma ionization chamber for relative neutron flux distribution measurement by means of activation method. Information on the construction, characteristics, and main parameters of the detectors is given. (auth)

25603 (PPAD-485-F) PRESSURE-DEPENDENCE OF SPARK SCATTER, SPARK WIDTH, AND EFFICIENCY IN A SPARK CHAMBER (thesis). Walter R. T. Witschey (Princeton-Pennsylvania Accelerator, Princeton, N. J.). May 6, 1963. Contract AT(30-1)-2137. 50p.

Spark chamber efficiency, defined as the ratio of the number of sparks that occur to the total number of gaps available, spark scatter, the distance an individual spark occurs from the most probable path of the particle, and spark width are investigated. These factors are dependent on applied voltage pulse height, rise, duration, and decay-time of the pulse, the time between the passage of a particle and the pulsing of the plates, applied magnetic field strength, the type of gas, and the gas pressure. Expressions that explain the behavior of a spark chamber with respect to efficiency, scatter, and spark width are examined for pressure dependence and related to experimental results. (C.E.S.)

25604 (TID-18762) THIN WALL ION CHAMBERS FOR LOW LEVEL RADIATION ENVIRONMENTS. Interim Technical Report. M. H. Shamos, A. Liboff, and J. Siderowitz (New York Univ., New York. Graduate School of Arts and Sciences). May 1963. Contract AT(30-1)-1704. 27p.

Ion chambers for measuring the environmental radiation have excellent characteristics if filled with electronegative gases such as Freon-12 and operated at low collecting fields so as to induce columnar recombination of the ions in the alpha tracks arising from radioactive contamination of the chamber walls. Freon-12 has the added advantage of high density and low electron temperature, giving the sensitivity of a pressurized chamber of roughly 4 atm and reducing the noise fluctuation in the gas. Several such chambers were constructed, some with ultra-thin windows, for operation at atmospheric pressure, and were used with success over a period of years. (auth)

25605 (AEC-tr-5700) STUDIES ON RADIATION ACTIVATED PHOSPHORS. (2). ON THE APPLICATIONS OF RADIATION ACTIVATED PHOSPHORS. Yasuo Ato, Ryoichiro Fujimura, and Masahiro Oishi. Translated from Nippon Isotope Kaigi Hobunshu, No. 4, 607-10(1962). 18p. (Includes original, 6p.).

It is noted that the activated phosphors that are readily prepared in the laboratory have very low intensity; however, it was found possible to investigate the temperature dependence of their luminescence, rate of decay, and other characteristics related to applications and limitations. Data and information concerning these features are presented. Phosphors of the ZnS type are found to be superior to others in their efficiency of emission and in their low degree of deterioration. (J.R.D.)

25606 LIQUID SCINTILLATION COUNTING: THE DETERMINATION OF BACKGROUND COUNTS OF SAMPLES CONTAINING QUENCHING SUBSTANCES. B. Scales (Imperial Chemical Industries Ltd., Alderley Park, Cheshire, Eng.). Anal. Biochem., 5: 489-96(June 1963). (In English)

A method is described for the accurate estimation of the background count of samples containing quenching substances assayed by liquid scintillation counting techniques. It is derived by measurement of the counting efficiency of the active samples, and application of a correlation curve of background count versus efficiency, constructed by use of inactive samples. The background count of C^{14}- and H^{3}-containing tissue samples, prepared using hydroxide of

Hyamine 10-X, could be estimated with an accuracy of at least ±4%. The background count of tissue samples prepared by dissolution in ethanolic potassium hydroxide could be determined with an accuracy better than ±4% for C^{14}- and better than ±6% for H^3-containing tissues. (auth)

25607 SOME DOSIMETRIC CHARACTERISTICS OF THE SMALL SBM-10 TYPE COUNTER. A. M. Panchenko. At. Energ. (USSR), 14: 408-9(Apr. 1963). (In Russian)

The sensitivity of detectors used for the intensity determination of γ radiation with complex spectral and angular distribution must be only slightly energy-dependent; the instrument must be small and must possess an isotropic sensitivity. The possibility of using a halide-type β counter, designated as SBM-10, for detecting γ radiation was investigated. The nominal operating tension of the counter is 400 v, with a level region of at least 100 v and a natural background of less than 8 pulses/minute. Best results were obtained with a 3-layer shield of Sn, Al, and Pb. In the energy range from 0.1 to 1.25 Mev, the average sensitivity of the counter was found to be 8.2×10^3 pulses/cm^2/Mev ± 11%. The isotopes Hg^{203}, Cr^{51}, Cs^{137}, Cs^{134}, Zn^{65}, and Co^{60} were used as γ radiation sources in the experiments; tests were also made with filtered x radiation. A Bakelite ionization chamber with walls covered with a conducting layer was used to measure the intensity of the incident γ radiation. The greatest divergence from normally incident γ quanta was noted at $E_\gamma = 0.28$ Mev. The lack of symmetry did not affect the angular sensitivity of the instrument. The counter with screen is considered suitable for determining γ radiation intensities with complex spectral and angular distributions. (TTT)

25608 A PHOTOGRAPHIC METHOD FOR PERSONAL β AND γ DOSIMETRY. V. F. Kozlov. At. Energ. (USSR), 14: 419-22(Apr. 1963). (In Russian)

In previous studies on the dosimetry of β and γ radiation by means of photographic emulsions, the joint action of these radiations on the emulsion was not taken into consideration. Studies were therefore carried out on the problems arising during the personnel monitoring of soft γ radiation in the 20- to 110-kev range and the determination of β radiation in mixed radiation fields. The darkening of the emulsion as a function of exposure to radiation was used as the criterion. The openings in the cassette were covered with various filters, making it possible to estimate the contribution and the energy of the γ quanta reaching the emulsion. Formulas were derived for estimating the β radiation at various energy levels. The method allows the β radiation to be determined in the 0.2- to 3.4-Mev range in the absence of γ radiation with a precision of ±20%; if the latter is present, the 40% error in its determination must be taken into consideration. (TTT)

25609 RECENT PROGRESS IN DOSIMETRY OF IONIZING RADIATIONS. F. Běhounek (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). At. Energy Rev., 1: No. 2, 37-97(1963). (In English)

A review is given of all methods of measuring ionizing radiation which have been developed during the past few years, i.e. the ionization chamber method, counting, chemical, photographic, colorimetric, luminescent, and calorimetric methods. Special attention is devoted to those dosimetric methods which have been studied more extensively – scintillation spectrometry, semiconductor detectors, luminescent chambers, and spark chambers. Some other methods are briefly mentioned together with the redetermination of some basic values and calibration and correction procedures. In conclusion, the most important progress achieved to date is reviewed and those fields where further improvement is most necessary are discussed. (auth)

25610 APPARATUS FOR THE MEASUREMENT OF MICROACTIVITIES: ABSOLUTE BETA MEASUREMENTS WITH 4π COUNTER. Y. Le Gallic. Bull. Inform. Sci. Tech. (Paris), No. 67, 3-11(Dec. 1962). (In French)

A study is made to determine the conditions which allow the threshold of the 4π counter to be sufficiently lowered while preserving a reasonable measurement time and a satisfactory precision (~5%). The essential characteristics of a 4π counter and its operational regime, electronic assembly, and operational characteristics are discussed. Precautions for the reduction of the self-pulse of the counter are discussed. (J.S.R.)

25611 APPARATUS FOR THE MEASUREMENT OF MICROACTIVITIES: RELATIVE BETA MEASUREMENTS. M. Thénard. Bull. Inform. Sci. Tech. (Paris), No. 67, 12-18(Dec. 1962). (In French)

The characteristics of a grid-multianode counter, chosen for relative beta measurements, are tabulated. The slope and efficiency of the counter constructed were determined. The association of two identical grid counters by placing the windows face to face gave a very high-efficiency device. The characteristics of this 3π counter and its factor of merit were analyzed. (J.S.R.)

25612 APPARATUS FOR THE MEASUREMENT OF MICROACTIVITIES: GAMMA SCINTILLATION COUNTERS. Y. Le Gallic, J. Legrand, and M. Thénard. Bull. Inform. Sci. Tech. (Paris), No. 67, 19-30(Dec. 1962). (In French)

The construction of γ scintillation counters of the microactivity type is reduced to a determination of the origin of contamination of the various detector constituents and to as great a reduction as possible in these contaminations so as to obtain the lowest possible self-pulse. The contamination of scintillation counters is discussed with a consideration of the sources of extraneous radiation in the photomultiplier, the NaI(Tl) scintillator, and the accessories (reflector, scintillator shield, and photomultiplier shield). The self-pulse of four scintillation counters is analyzed in order to make evident the results of the study of the contamination sources. The calculation of the measurement threshold is illustrated. (J.S.R.)

25613 APPLICATIONS: MEASUREMENT OF VERY LOW NEUTRON FLUX. P. Gauthier, Y. Le Gallic, and B. Grinberg. Bull. Inform. Sci. Tech. (Paris), No. 67, 63-5(Dec. 1962). (In French)

The measurement of "neutron puffs" by a method based on the Szilard-Chalmers effect in a $Ca(MnO_4)_2$ solution is discussed. The measurement and the analysis apparatus are described. (J.S.R.)

25614 APPLICATIONS: GAS CONTAMINATION. J. M. Blondel. Bull. Inform. Sci. Tech. (Paris), No. 67, 66-73 (Dec. 1962). (In French)

The method used for the measurement of the contamination of counter filling gas was differential gaseous counting. The principle and the apparatus used are described. The gases studied were propane–argon, propane–krypton, propane–xenon, and isobutane–helium. The results are tabulated and show the importance of an accurate knowledge of the gas radioactivity in the measurement of low activities. (J.S.R.)

25615 APPLICATIONS: QUANTITATIVE GAMMA SPECTROMETRIC ANALYSIS IN MICROACTIVITY. J. Legrand, G. Mallet, and Y. Le Gallic. Bull. Inform. Sci. Tech. (Paris), No. 67, 74-80(Dec. 1962). (In French)

The applicability of the least-squares method to the analysis of γ spectra is discussed with a consideration of the principle, experimental verification, limitation, and sensitivity of the method. Illustrations are given of the application of this method to the analysis of γ and β spectrometry. (J.S.R.)

25616 A TISSUE-EQUIVALENT CHEMICAL DOSIMETER SENSITIVE TO 1 RAD. W. A. Armstrong, R. A. Facey, D. W. Grant, and W. G. Humphreys (Defense Research Chemical Labs., Ottawa). Can. J. Chem., 41: 1575-7(June 1963). (DRCL-403) (In English)

The system 10^{-4}M terephthalic acid in 4×10^{-4}M NaOH is capable of measuring doses of ionizing radiation as low as 500 millirads. The concentration of hydroxyterephthalic acid, determined spectrophotofluorometrically, increases linearly with dose to at least 1000 rads and is independent of dose rate from 0.5 to 1000 rad/min. The energy dependence and stability of the system are also reported. (auth)

25617 THE "TOTAL HUMAN BODY COUNTER" OF BOLOGNA. Carlo Melandri, Vittorio Prodi, and Otello Rimondi (CNEN, Bologna). Comit. Nazl. Energia Nucl., Notiziario, 9: 60-3(Apr. 1963). (In Italian)

The characteristics and construction of the total human body counter at Bologna are described. Typical spectra obtained are shown. (J.S.R.)

25618 DOSIMETRY OF 152-MEV PROTONS WITH A SOLUTION OF POTASSIUM BICHROMATE. Odette Bagno, Claude Stephan, and Paul Bonet-Maury (Faculte des Sciences, Orsay, France). Compt. Rend., 256: 3516-19 (Apr. 17, 1963). (In French)

The acid solution of potassium bichromate is a good dosimeter for ionizing radiations in the absorbed dose region between 1 and 2×10^5 rads; for 152-Mev protons $G = 0.81 \pm 0.03$. (tr-auth)

25619 STATISTICAL MEASURES OF THE LOWER LIMIT OF DETECTION OF A RADIOACTIVITY COUNTER. Bernard Altshuler and Bernard Pasternack (New York Univ., New York). Health Phys., 9: 293-8(Mar. 1963). (In English)

The lower limit of detection of a counter is best expressed statistically in terms of two minimal activities determined by the maximal acceptable risks of making a Type I error (of concluding there is sample activity when there is none) and a Type II error (of concluding there is no activity in the sample when there is some). These threshold activities are designated "the minimum significant measured activity," defined to be the smallest measurement which is interpreted as meaning there is activity in the sample, and "the minimum detectable true activity," defined to be the smallest amount of activity required to be in a sample in order that a measurement can be expected to imply correctly the presence of activity with a predetermined degree of confidence. It is to be noted that the former refers to a measurement while the latter refers to the actual activity present. The statistical problems of the definition and derivation of these two measures of detection sensitivity is discussed. Though either quantity can serve equally well as a measure of detection threshold, it is important to recognize the distinction between the threshold for measured activity and the threshold for true activity and their different applications—the former dealing with measurements meriting being reported as greater than zero and the latter with the amount of actual activity that can be detected with predetermined confidence. (auth)

25620 LOW LEVEL IN VIVO MEASUREMENT OF IODINE-131 IN HUMANS. Gerard R. Laurer and Merril Eisenbud (New York Univ., New York). Health Phys., 9: 401-5(Apr. 1963). (In English)

The calibration of a whole body counter for the measurement of pC amounts of I^{131} in human thyroids is described. Two 3-in. diameter by 2-in. thick sodium-iodide crystals are used, connected in parallel and placed on each side of the neck over the thyroid area. Thyroid burdens as small as 20 pC may be measured at a 90 per cent confidence level with a 30-min counting period using the in vivo method described. (auth)

25621 ACCURACY AND SENSITIVITY OF FILM MEASUREMENTS OF GAMMA RADIATION. PART I. COMPARISON OF MULTIPLE-FILM AND SINGLE-QUARTERLY-FILM MEASUREMENTS OF GAMMA DOSE AT SEVERAL ENVIRONMENTAL CONDITIONS. Allen Brodsky and Ronald L. Kathren (Univ. of Pittsburgh). Health Phys., 9: 453-61(May 1963). (In English)

Experiments were performed to determine the inherent variations in film measurements of gamma radiation for several temperatures and humidities and for weekly, bi-weekly, 4-weekly, 6-weekly, and 12-week replacement intervals. Results show that the weekly replacement interval produces the most precise evaluation of cumulative 12-week exposures for unprotected packets, provided that low densities and dose assignments are recorded as read and weekly dose assignments are picked from calibration curves plotted from films developed along with the corresponding batches. Bi-weekly films give quarterly dose estimates that may be low by 30 per cent, showing the increasing effects of latent image fading after the first week, particularly at high humidities. Humidity dependence and temperature dependence were found to be interrelated, and an increased fogging was noted for the 12-week films, which predominated over the fading effect, and which was more pronounced at the higher temperature. Unprotected films exposed for periods longer than two weeks were generally found to give unreliable measurements. (auth)

25622 ACCURACY AND SENSITIVITY OF FILM MEASUREMENTS OF GAMMA RADIATION. PART II. LIMITS OF SENSITIVITY AND PRECISION. Allen Brodsky (Univ. of Pittsburgh). Health Phys., 9: 463-71(May 1963). (In English)

The dose assignments from the 12-week experiment described in Part I in which weekly sets of duPont Type 555 films were exposed to gamma radiation under different environmental conditions and at several dose levels are used to estimate the limits of precision and sensitivity of current methods of personnel monitoring. The standard deviation in the total dose assignment for a cumulative dose of 120 mr delivered to twelve weekly films, each exposed to 10 mr, was ±12.3 mr; the standard deviation would be no more than ±19 mr for any distribution of the 120 mr among the twelve weekly films. Currently available film processing methods are shown to be inherently capable of measuring gamma dose levels as low as 2 mr/week to within 25 per cent standard deviation or less over a period of 52 weeks. The number of silver grains produced per mr of gamma radiation was found to be sufficient to allow the measurement of fractions of background dose levels with weekly films, if more sensitive methods of densitometry can be developed. These estimates of precision do not include such errors as uncertainties in calibration source strength or field monitoring variations that

would affect any method of personnel monitoring, regardless of sensitivity or precision. (auth)

25623 THE ROLE OF RADIATION SPECTROMETRY IN OPERATIONAL HEALTH PHYSICS. J. R. Keane, L. Salmon, and A. E. R. Toureau (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Health Phys., 9: 485-501(May 1963). (In English)

In the investigation of minor incidents involving the spread of radioactivity at atomic energy establishments, identification and measurement is required of the radioactive nuclides involved. These measurements assist in estimating the magnitude of the release and in discovering its source. Examples are given of the role of alpha, beta, and gamma spectrometry in Health Physics investigations of such incidents at A.E.R.E. Harwell. Among the items discussed are the contamination of reactor areas by fission products and the activation of reactor construction materials, the spread of fission product activity in disposal operations, and the identification of activity in external body contamination. In these and in other cases spectrometry has been found to be a powerful tool for the rapid analysis of radioactive samples. (auth)

25624 AN AUTOMATIC SAMPLE CHANGING SYSTEM FOR A LARGE CRYSTAL GAMMA SCINTILLATION SPECTROMETER. R. H. Schneider, G. Von Gal, Jr., B. Kahn, and M. W. Carter (Dept. of Health, Education and Welfare, Montgomery, Ala.). Health Phys., 9: 551-3(May 1963). (In English)

A mechanism was designed and constructed for the storage, indexing, and automatic changing of up to 20 large samples on a scintillation detector mounted in a large cave-type shield. A conveyer and a latched mechanical device are used to transfer the samples between the storage area and the detector. (D.L.C.)

25625 HIGH-RESOLUTION CATHODE-RAY TUBE FOR THE SCANNING OF NUCLEAR TRACK PHOTOGRAPHS. D. Maeder (Université, Geneva). Helv. Phys. Acta, 36: 198-215(1963). (In German)

Current production rates of bubble chamber and spark chamber track photographs suggest the use of cathode-ray tube techniques for automatic evaluation. Desirable spatial and time resolution specifications for the measurement of bubble tracks are listed, the most important one being $r_{spot} \lesssim 10^{-4}$ screen diameter. Electron-optical limitations are discussed. Assuming an optical solid angle of 10^{-4}, the required energy density was determined; with 25 kv accelerating voltage the half-angle of beam convergence had to exceed 0.005 radians. Deflection angles compatible with good focusing required a minimum beam length corresponding to $r_{aperture} \gtrsim 0.9$ mm. Estimates of focus aberrations demonstrated that a magnetic system must be used. Screen loading could be kept within safe limits by restrictions on the scanning pattern. Deflection aberrations are shown to become so large (assuming ±30° deflection) that special correction and/or calibration techniques should be applied. Experimental results on a Ferranti type 5/74 QM tube are presented. The tube is described and test circuitry built at CERN outlined. Resolution tests show that programed focus and astigmatism corrections are essential to reach the limit $r_{spot} \approx 11$ μ everywhere in the 80 × 80 mm^2 field. Distortion tests revealed differential nonlinearities of 22% along the x and y axes. When these were corrected there remained a pin cushion distortion (25% along diagonals), a nonorthogonality, and a spiral distortion (0.5°). Correction procedures reduced integral distortions to ± 2% of the field diagonal. Light output tests revealed strong local fluctuations which disappeared when the spot was defocused. Absolute intensity and speed of response were compatible with scanning requirements. An outlook to practical applications is sketched. Some formulas and a numerical table on space charge defocusing were compiled. (auth)

25626 COINCIDENCE COUNTING CORRECTIONS FOR DEAD-TIME LOSS AND ACCIDENTAL COINCIDENCES. J. Bryant (Radiochemical Center, Amersham, Bucks, Eng.). Intern. J. Appl. Radiation Isotopes, 14: 143-51(Mar. 1963). (In English)

An exact correction formula for coincidence counting with equal nonextending dead times in the two detector channels is derived and compared with approximate 4π β/γ-coincidence counting correction formulas. The difficulties in extending the method of derivation to the case of unequal dead times are discussed. (auth)

25627 DEAD-TIME CORRECTIONS IN THE MEASUREMENT OF SHORT-LIVED RADIONUCLIDES. E. J. Axton and T. B. Ryves (National Physical Lab., Teddington, Middx., Eng.). Intern. J. Appl. Radiation Isotopes, 14: 159-61(Mar. 1963). (In English)

Graphs are presented which give the magnitude of the error introduced by the application of simple dead-time corrections to observed average counting rates during counting periods extending over several half lives. (auth)

25628 RELATION BETWEEN THE ABSORPTION AND THE QUENCHING OF LIQUID SCINTILLATION SAMPLES. J. De Bersaques (Univ. of Ghent). Intern. J. Appl. Radiation Isotopes, 14: 173-4(Mar. 1963). (In English)

During scintillation counting of labeled amino acids in hairs, brown-colored solutions were formed when the hairs were dissolved in Hyamine X-10. In order to see whether the quenching is related to the optical density of the solution, measurements with a Tri-Carb spectrometer were made on solutions of hair, phosphor, and H^3-leucine or S^{35}-cystine. The relation between quenching and density at 430 mμ was found to be linear up to 50% quenching for both labeled compounds. (D.L.C.)

25629 THE POSSIBILITY OF USING A TOROIDAL, SECTOR, MAGNETIC FIELD IN γ-SPECTROMETRY. E. A. Arutyunyan, Yu. V. Khol'nov, and G. E. Shchukin (Khlopin Radium Inst., Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 177-81(Feb. 1963). (In Russian)

A magnetic γ spectrometer, which utilizes the recoil electrons knocked out of a thin target by the γ rays, can be used to obtain a γ energy spectrum. A half-width of 0.75 to 1.0% for a 1-Mev γ ray can be readily attained with double focusing of the recoil electrons, but the counting efficiency of the system drops to such a low value that curies of activity may be required to obtain the complex, γ spectrum. The efficiency can be improved by using two, symmetrical, sectored toroidal magnets in succession with axial symmetry for double focusing of the recoil electrons. In this case, the solid angle subtended by the source can be increased from 0.04% to 19% of 4π. Experiments were run on a split toroidal spectrometer of this type. The field was also toroidal with $H = H_0/r$. Only one slot out of six possible slots was used. The target from which the recoil electrons were knocked out by the γ rays had a thickness of 5.4 mg cm^{-2}. The solid angle was 0.7% of 4π (a factor of 24 greater than in earlier models). The counting efficiency for the 1112-kev γ ray from Zn^{65} was a factor of 2.34 greater than in earlier models of the instrument. The efficiency would be a factor of 14 greater with the use of all six slots instead of one slot. The use of a toroidal

spectrometer which was free of iron would increase the counting efficiency even more. (TTT)

25630 CALCULATIONS FOR A β-SPECTROMETER HAVING SPLIT AND TWO-FOLD FOCUSING AT AN ANGLE OF $\pi\sqrt{2}$. M. A. Listengarten. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 290-4(Feb. 1963). (In Russian)

The trajectories of electrons moving in a magnetic field were calculated for a beam of particles undergoing simultaneously split and two-fold focusing. The results of the calculations were used to design the slits and diaphrams in a β spectrometer. Terms to the fifth order were taken into account in making the calculations. The mathematical results are expressed as a series expansion of small terms. The equations of motion were solved by the method of successive approximations. A total of 440 points were calculated for the angles $\pi\sqrt{2}$ and $2\pi\sqrt{2}$ for various trajectories. The form of the slit in the $\pi\sqrt{2}$ focal point is shown graphically for slit widths w = 0.015 and 0.010 (in fractions of the radii). The position of the beam is shown graphically for four angles ψ = 140, 200, 254, and 340°. The contours of the diaphram are also shown. (TTT)

25631 THE THEORY OF THE ACTION OF A PROPORTIONAL COUNTER. G. E. Kocharov and G. A. Korolev (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 301-7(Feb. 1963). (In Russian)

The amplification coefficient of a proportional counter is given by the expression: $\ln A = \int_{r_a}^{r_1} \alpha \, dr$. Here, α is the number of ion pairs formed by an electron per unit path length, r_a is the radius of the wire, and r_1 is the radius at which the shower of charged particles begins. The differences in various theories of determining the amplification factor lies generally in the means of determining α and r_1. The amplification coefficient was measured on a proportional counter having an internal diameter of 65 mm and a length of 300 mm. A platinum wire with a diameter of 50 μ served as the anode. A U^{234} α source was used as an ionizing agent. Pure argon, a mixture of 50% Ar + 50% methane, and a mixture of 99.8% methane and 0.2% argon were used as filling gases. The formula of Rose and Korffs in Phys. Rev., 59, 850 (1941) with corrections as given by Curran and Craggs in Counting Tubes, Academic Press, 1949, the formula of Khristov in Dokl. Bolgarsk., AN, 10, 6, 453 (1957), and the formula of Ditkorn given by Kiser in Appl. Scient. Res. B, 8, 183 (1960) were used to plot the experimental data. All these formulas were in satisfactory agreement with the experimental data. The amplification depends only on the nature of the gas, and the data could be plotted to give a straight line for any pressure and geometry of the counter. The various constants in these formulas were determined so that the amplification for a given gas can be calculated at any geometry and voltage of the counter. A certain preference can be given to the formula of Ditkorn, because the amplification can be calculated in a number of cases without preliminary experimentation. (TTT)

25632 PROPORTIONAL COUNTERS FOR X-RAYS AND EXPERIMENTS INVOLVING THEIR APPLICATION IN X-RAY SPECTRAL ANALYSIS. K. I. Narbutt, S. M. Perel'man, I. A. Prager, and V. A. Kharlakov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 430-7(Mar. 1963). (In Russian)

Two types of proportional counters for the detection of x rays are described. One type has a side entrance window while the other has an aperture in the front portion of the counter. All windows are made of beryllium foils whose thicknesses are in the range 150 to 200 μ. The counter with the side entrance is constructed completely of metal; a 34 mm diameter cylinder, 150 mm in length, serves as the cathode while a 0.1 mm molybdenum wire functions as the anode. To decrease the dead volume of the front-window counter and the influence of edge effects on the counter resolution the anode filament is bound directly to the front of the glass bulb. In this way the dead volume is made up only by the thickness of the glass itself, about 1.5 mm. Performances of the two types of counters were examined using x rays from various elements. Several electric characteristics are investigated and plotted: the dependence of the pulse amplitude on the operating voltage, and, the dependence of the pulse length and the pulse growth time on the load resistance. Also, the dependence of the counter resolution on the operating voltage and on the load resistance is discussed. (TTT)

25633 PROPORTIONAL COUNTERS FOR X-RAYS. D. A. Goganov and G. P. Gogolev (Special Construction Bureau for X-ray Equipment, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 438-45(Mar. 1963). (In Russian)

The construction and the parameters of two types of proportional counters, designed for the investigation of x-ray structures and x-ray spectra, are described. The counters are of the side entrance variety. The cathode cylinder is made of copper, while a tungsten wire, 0.1 mm in diameter serves as the anode. The entrance (0.2 mm) and exit (1 mm) windows consist of beryllium disks. Two types of counters are described: one in which the ratio of the wire length to the counter diameter is 3 to 1, and, the other in which this ratio is 2 to 1. A mixture of xenon and methane is employed as the counting gas. Various electronic characteristics of the counters were investigated and discussed. The counters were found to be effective for x rays in the range from the chromium K_α line to the molybdenum K_α line. The resolution of the counters was found to be such that they can be used to analyze spectra for elements differing from one another in atomic number by four. (TTT)

25634 PROPORTIONAL COUNTERS FOR SOFT X-RAYS. A. P. Lukirskii, I. A. Brytov, and O. A. Ershov (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 446-51(Mar. 1963). (In Russian)

Investigations concerning the practical use of flowing proportional counters and the determination of the efficiency of these counters are described. A system is described for continuously supplying gas in and out of the counter with a rather small consumption of gas. By using a 4-micron window these counters can be used in a vacuum monochromator for the detection of radiation up to 13.3 Å in wavelength. The resolution of the counters was investigated as a function of the operating voltage using the aluminum K_α line with samples of varying counting rates. The efficiency of the counters was determined for various wavelength radiation, different gas mixtures, and various cathode diameters. The resolution was also investigated as a function of the window size. (TTT)

25635 DYNAMIC COMPRESSOR FOR PROPORTIONAL COUNTERS. János Soós. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 147-54(1963). (In Hungarian)

The output pulse heights of 4 π proportional counters used for the measuring of $\alpha-\beta$ radiating sources vary in a very wide range from a few tenth of mv to 10 v. In order to amplify these pulses possibly without loss and to reduce the high amplitude dynamics, a dynamic compressor was designed. The problems arising, the various aspects and methods involved in the design of compressor circuits as well as the features and particulars of the apparatus are given. (auth)

25636 APPLICATION OF A BF_3 COUNTER AS IONIZATION CHAMBER. Ervin Zobor. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 159-60(1963). (In Hungarian)

The application of a CHM-5 /SzNM-5/ BF_3 counter as ionization chamber is briefly described. The ionization chamber characteristics are also given and the mean two-year operational experience on the ZR-1 critical assembly is summarized. (auth)

25637 MEASUREMENT OF TRITIUM AND C-14 WITH LIQUID SCINTILLATORS. Enrico Petrozzi. Minerva Nucl., 7: 91-103(Mar. 1963). (In Italian)

A description is given of the various types of equipment used for the liquid scintillation counting of soft β emitters. Some typical data on sensitivity, efficiency, quality figure, and noise encountered in the various measurements are reported. The techniques most frequently used for preparing the samples and for carrying out the measurements are reviewed, and several laboratory procedures are described. The questions of luminescence, refrigeration, type of vial, phototube, and scintillator solutions are also discussed from a practical standpoint. Tritium determinations in natural waters, gas chromatography, and health physics measurements in nuclear plants are mentioned. (auth)

25638 PARTICLE IDENTIFICATION BY PULSE SHAPE DISCRIMINATION IN THE p-i-n TYPE SEMICONDUCTOR DETECTOR. C. A. J. Ammerlaan, R. F. Rumphorst, and L. A. Ch. Koerts (Institutt voor Kernphysisch Onderzoek, Amsterdam). Nucl. Instr. Methods, 22: 189-200(Apr. 1963). (In English)

When an ionizing particle enters a semiconductor radiation detector a voltage pulse is produced. The final pulse height is determined by the particle energy, while the range of the particle affects the shape of the pulse. The voltage pulse therefore contains information about the particle type. The pulse height at a fixed time during the pulse rise time is used as the range dependent quantity. A two-dimensional display of this quantity versus the energy of the particle showed that separation could be obtained between deuterons and α-particles with energies in the range from 8 to 26 Mev. Calculations were made on this effect based on the results of a pulse shape analysis. The agreement between the experimental and the calculated data proves that the theoretical picture is quite adequate. (auth)

25639 SOME DATA FOR A SIX GAP BETA RAY SPECTROMETER. K. M. Bisgård (Universitet, Aarhus, Denmark). Nucl. Instr. Methods, 22: 221-37(Apr. 1963). (In English)

Data related to the construction and performance of a six gap beta ray spectrometer, an enlarged version of the first Copenhagen model, are given. Its magnet system has a diameter of 100 cm in the central plane. The distance between source and focus is 340 mm and the dispersion amounts to about 600 mm. An electron energy range from about 5 kev up to more than 5 Mev is covered. A method for shaping of the pole plates is described. Corresponding values of resolution and transmission are determined and compared for different parts of one gap, three gaps, and all six gaps. At resolution settings of 0.4, 0.8, and 1.4% transmission values of 1, 5, and 10%, respectively, can be used. An account is given of problems related to earth field compensation and energy calibration. Optimum conditions are discussed and the performance compared with the performance of some other spectrometers. The design of an electron-electron coincidence spectrometer of which the two halves can be used as single electron and electron-gamma angular correlation spectrometers is outlined briefly. (auth)

25640 PHOTOMULTIPLIER SINGLE-ELECTRON STATISTICS AND THE SHAPE OF THE IDEAL SCINTILLATION LINE. J. R. Prescott (Univ. of Alberta, Calgary). Nucl. Instr. Methods, 22: 256-68(Apr. 1963). (In English)

A study was made of the particular role of the photomultiplier in determining pulse-height resolution in a scintillation counter assembly. The contribution to photomultiplier noise of single electrons from the photocathode is discussed. It is shown that although the overall resolution depends sensitively on the frequency distribution of single-electron pulses, a statistical model can be formulated which leads to an expression for the shape of the ideal scintillation line, which adequately represents actual line shapes and which is not itself sensitive to the details of the single-electron distribution. It is suggested that the same expression may be appropriate for describing the line shape in proportional counters. (auth)

25641 BACKGROUND OF COINCIDENCE TYPE BETA-RAY SCINTILLATION SPECTROMETER. E. Tanaka and T. Hiramoto (National Inst. of Radiological Sciences, Japan). Nucl. Instr. Methods, 22: 292-300(Apr. 1963). (In English)

The performance of the low background β-ray scintillation spectrometer using a coincidence method with a G-M counter is described. The background spectrum of the coincidence spectrometer is correlated theoretically to the background spectrum of the scintillation counter. If the latter spectrum is represented by a simple exponential function of energy E, $B_0e^{-\mu E}$, the former spectrum is also similar in shape and its counting rate is reduced by a factor of $\epsilon kS/4\mu V$, where ϵ, V, S, and 1/k are the intrinsic efficiency of the G-M tube, the volume of the scintillator, the total surface area of the G-M tube, and the energy loss of electron per unit path length in the scintillator, respectively. The results of calculation were examined experimentally with three detectors of different shapes and sizes. The energy spectrum of electrons which cause the background counts of a G-M counter is also discussed. (auth)

25642 AN AUTOMATIC SINGLE CHANNEL SPECTROMETER FOR QUICK QUANTITATIVE ANALYSIS. K. Subrahmanyam (Atomic Energy Establishment, Trombay, India). Nucl. Instr. Methods, 22: 301-5(Apr. 1963). (In English)

A set-up for quick qualitative and quantitative analysis of radioactive isotopes with a modified single channel scintillation spectrometer is described. The whole operation is automatic and the stability and the accuracy of the electronic equipment is found to be good when compared to conventional set-ups. Activities ranging between few microcuries to few milli microcuries are acceptable. The total time of operation can be varied from a few minutes to a few tens of minutes. The spectrum can either be displayed on a C.R. tube of sufficiently long persistance or can be recorded on a recorder. (auth)

25643 A COMPTON REJECTION GAMMA RAY SPECTROMETER; UTILIZATION OF THE A.C. SHIELD AS A WELL TYPE COUNTER. G. Busuoli (CNEN, Bologna), C. Melandri, O. Rimondi, and B. Righini. Nucl. Instr. Methods, 22: 324-32(Apr. 1963). (In English)

A Compton rejection gamma ray spectrometer is described which is formed by a 2 in. × 1¾ in. NaI(Tl) crystal placed in a hole drilled in a 29.8 cm dia × 26.4 cm high cylindrical plastic scintillator. This ensemble is surrounded by a 20 cm thick iron shield. This apparatus gives a peak-to-total area ratio R of 0.610 for Cs^{137}, 0.542 for Mn^{54}, and 0.445 for Zn^{65}. For example, in the quantitative

determination with a 9% error of Cs^{137} in a mixture of Cs^{137} (7.5×10^2 pC) + Zn^{65} (4.5×10^4 pC) this device reduces the counting time from 74 to 20 minutes. The crystal background in the range from 0.1 to 3 Mev is also decreased by a factor of 54 by Fe shielding and furtherly of 2.3 by a-c device. In the specified interval the background counting rate is 37.8 cpm. This equipment is moderately priced and highly versatile: in particular the a-c mantle can be used as a well type counter or even as a total body monitor for small animals. When it is used as a well counter, it is so sensitive as to detect few pC/cm^3 of a gamma emitting nuclide, with gamma energy around 1 Mev, dissolved in a 350 cm^3 solution, as in the case of Mn^{54} or Co^{60}. (auth)

25644 EMULSION AS A DETECTOR OF INDIVIDUAL ELECTRONS FOR USE IN BETA-SPECTROSCOPY. K. D. Sevier (Uppsala Univ.). Nucl. Instr. Methods, 22: 345-50 (Apr. 1963). (In English)

A procedure for employing "electron sensitive" nuclear research emulsions as a means of detecting individual beta particles in a semi-circular spectrograph is presented. The beta spectrum may then be determined by plotting the number of electron tracks per unit area (counted with the aid of a microscope) as a function of position on the plate. Treatment of the emulsion plates is described and suggestions are given for increasing the quality of results. Intensity measurements of conversion lines can be made with great accuracy and the full resolving ability of the spectrograph can be taken advantage of. The method is found to be most effective for electrons of energies below about 40 kev having a detection efficiency of ~95% down to 10 kev. The M_I, M_{II}, and M_{III} conversion lines of the 40 kev transition in Tl^{208} are shown with a line half-width of 0.09%. (auth)

25645 GAMMA RAY SPECTROSCOPY USING A GERMANIUM LITHIUM-DRIFTED DIODE. P. P. Webb and R. L. Williams (RCA Victor Co. Ltd., Montreal). Nucl. Instr. Methods, 22: 361-2(Apr. 1963). (In English)

Ge diodes with Li-drifted depletion layers are shown to be advantageous for gamma ray spectroscopy. The 122 and 136 kev lines of the Co^{57} spectrum are readily resolved from the Compton background. The Cs^{137} spectrum has a photoelectric peak about twice the height of the Compton background. It is pointed out that a Ge Li-drifted diode will require additional drifting after each use. (D.L.C.)

25646 DIFFERENCE OF SHAPE OF SCINTILLATION PULSES FROM ORGANICS DUE TO ELECTRONS AND TO ALPHA PARTICLES. Y. Gervais de Lafound and J. Bouyssou (Faculté des Sciences, Toulouse). Nucl. Instr. Methods, 22: 365-6(Apr. 1963). (In French)

The fast and slow components of the decay of a scintillation pulse in an organic scintillator are analyzed. Two cases are considered: that in which $\tau_1 \cong RC \ll \tau_2$; and that in which $RC \gg \tau_2$. RC is the resistance-capacitance product in the photomultiplier, and τ_1 and τ_2 are the fast and slow decay constants, respectively. The results are studied experimentally using alpha particles and electrons. (T.F.H.)

25647 A NEW LIQUID SCINTILLATOR. M. A. Meyer, N. S. Wolmarans, and J. J. Van Der Walt (Potchefstroom Univ. for C.H.E., South Africa). Nucl. Instr. Methods, 22: 371-2(Apr. 1963). (In English)

Medicinal paraffin as a solvent for liquid scintillators offers the advantages of low cost, high flash point, and no deleterious effects on perspex containers. The light output of medicinal paraffin containing 3 g/l PPO and 0.02 g/l POPOP was found to be 26% of that of toluene containing the same scintillator concentrations. Addition of 90 g/l naphthalene to the medicinal paraffin solution increased its relative light output to 67%. (D.L.C.)

25648 OPERATION OF BUBBLE CHAMBER WITH LIQUID NITROGEN AND LIQUID ARGON. D. Pellett and R. Stump (Univ. of Kansas, Lawrence). Nucl. Instr. Methods, 22: 373-4(Apr. 1963). (In English)

The sensitivity of liquid Ar and N_2 to Compton-scattered electrons from γ rays was measured as a function of initial pressure up to the foam limit. The operating parameters of a number of liquids used in bubble chambers are tabulated for comparison. The relation between fluorescence and sensitivity of liquid Ar is discussed briefly. (D.L.C.)

25649 THE THEORY OF COUNTING RATE METER. F. H. Froehner (Technische Hochschule, Munich). Nukleonik, 5: 82-5(Feb. 1963). (In German)

The effect of the time constant of a recording counting-rate meter on the shape of the recorded curve was theoretically investigated, especially for the practically important case of a single line in the presence of a constant background. For line displacement, depression, and broadening, curves were calculated which could be used for a more accurate analysis of γ spectra (energy and intensity measurements) or in the study of scintillators (linearity and resolution). The value of the time constant necessary for an optimum signal-background ratio at a given line width was determined. It was shown that the probability with which it is a question of a pure line and not a statistical oscillation can be estimated from the height and width of an observed line at given time constants. (tr-auth)

25650 THERMOLUMINESCENCE DOSIMETRY. PART III. LUMINESCENCE AND NUCLEAR IRRADIATION. R. Schaves and C. Brooke. Rev. M.B.L.E., 6: 5-29(Apr. 1963). (In French)

A review of the role played by the various anomaly centers of a crystal in the process of capture and recombination of excited states created by nuclear irradiation is presented. The main features of the transport between various types of centers of these excited states and of the luminescence resulting from their recombination are then discussed. Emphasis is laid on the properties of the traps causing the luminescence time spread. The principles governing the filling of the centers by moving carriers or excitons were studied. Special attention was paid to the distribution of carriers between centers of a composite crystal caused by various types of excitation energy (photons, light or heavy particles) and to their total amount (phenomena of saturation and linearity, disexcitation under the influence of excitation energy itself). The release of deeper traps is bound to a correlative variation of the luminescence in relationship with time. The properties of the luminescence centers where recombination takes place were examined. Their variations were related to the temperature and to exchanges and competitions between the various types of centers. The influence of the shallow traps whose main role, outside the short-lived luminescence, lies in charge carrier transfer to other centers, is outlined. Deep traps, the true captors of luminescence, were studied. This frozen luminescence is unclamped by accelerating the emptying of traps through exposition to a high temperature. The aspect of luminescence under constant temperature was examined. A qualitative explanation is given of the appearance of thermoluminescent peaks when the temperature increases monotonically. A quantitative example specifies the thermoluminescence curves when the emptying goes together with predominant recombina-

tion. The possibilities of application of thermoluminescence curves to dosimetry as well as the technique of optimum heating were deduced. A review of the properties required from phosphors in order to be suitable for dosimetry is presented. (auth)

25651 THERMOLUMINESCENCE DOSIMETRY. PART IV. THE PNP 080 THERMOLUMINESCENT DOSIMETER. R. Schayes, M. Lorthioir, and M. Lheureux. Rev. M.B.L.E., 6: 31-67(Apr. 1963). (In French)

The principles of thermoluminescence are outlined and the thermoluminescent properties of calcium fluoride are described. The effects of gamma and beta excitation are considered and some results of light excitation are given. Correlation with the functions of crystal centers is given and the resulting variability of artificial and natural fluorites shown. The properties of the phosphor used in the PNP 080 dosimeter were studied mainly at the point of view of traps characteristics, aging, and light spectra. A description is presented of the PNP 080 dosimeter characteristics. The device has a linear response for doses ranging from a few milliroentgen up to a few thousands of roentgen. The reading reproducibility amounts to a few %. The apparatus can be stored indefinitely and can be used repetitively without any deterioration of precision. No influence of ambient temperature from −20 to +60°C was noticeable whether at the time of irradiation or during storage. The dosimeter energy response is satisfactory from 80 kev to 2 Mev. A description is given of the mechanical performances of the apparatus which can withstand the most severe conditions of use. (auth)

25652 DENSITY OF PARTICLE TRACKS IN THE HYDROGEN BUBBLE CHAMBER. B. N. Fabian (Univ. of Kentucky, Lexington), R. L. Place, W. A. Riley, W. H. Sims, and V. P. Kenney. Rev. Sci. Instr., 34: 484-95 (May 1963).

Measurements were made of the density of charged-particle tracks in the Brookhaven 20-in. hydrogen bubble chamber as a function of particle velocity and chamber operating conditions. The track density m is given by the function $A(P_s)^n\beta^{-2}$ where, at 27°K, $A = 7.5 \times 10^{-8}$ bubbles/cm of track, n = 5.4, and P_s is the superheat pressure in psia in the chamber. The pressure superheat dependence $\Delta m/(m\Delta P_s) \cong 10\%$ per psia; for tracks at different temperatures but with the same pressure superheat, the temperature dependence $\Delta m/(m\Delta T)$ is in the range 5 to 15% per 0.1°K, over the region of normal chamber operation. Macroscopic bubbles grow at the rate 0.21 mm $msec^{-\frac{1}{2}}$, until they are quenched by chamber recompression in proportion to their degree of internal energy. The measured track density dependencies are consistent with the view that bubbles originate on stopped secondary electrons produced in close collision processes, where distant collision influence is suppressed by the density effect much more for hydrogen than for the heavier bubble chamber liquids. It is shown that formation and growth of bubbles to critical size may be understood in terms of conventional fluid dynamics provided the expansion is extremely rapid. The secondary electron energies required for bubble formation at 27°K range from 80 to 292 ev depending on the superheat of the chamber. (auth)

25653 VERSATILE TECHNIQUE FOR MEASURING FLUORESCENCE DECAY TIMES IN THE NANOSECOND REGION. O. J. Steingraber and I. B. Berlman (Argonne National Lab., Ill.). Rev. Sci. Instr., 34: 524-9(May 1963). (TID-17874; UAC-7045)

A new method of accurately recording scintillation pulse contours over several decades is described. Scintillation pulses are analyzed by an apparatus which combines the very fast rise time of a pulse sampling oscilloscope and the digital storage capacity of a multichannel analyzer. A special feature of this technique is its ability to accept, within limits, pulses random in time and amplitude so that fluorescence from samples excited either by pulsed uv radiation, β, or α particles may be analyzed. This apparatus, in combination with a hydrogen flash tube and a monochromator, was used to measure the decay time of fluorescent solutions as a function of the wavelength of the exciting radiation. Decay time measurements were also made for various modes of excitation: α particle, β particle, and pulsed uv. (auth)

25654 EXTENSION OF THE NBS P2 CHAMBER CALIBRATION TO 260 Mev. William P. Swanson, Richard A. Carrigan, Jr., and Edwin L. Goldwasser (Univ. of Illinois, Urbana). Rev. Sci. Instr., 34: 538-40(May 1963).

The NBS P2 ionization chamber was calibrated for use in bremsstrahlung beams of maximum energy E_0 in the range 150 to 260 Mev, by a pair-spectrometer method, normalized to the previous NBS calibration at E_0 = 170 Mev. The response of the P2-4 chamber at 20°C, and 760 mm Hg, at 149, 199, 229, and 258 Mev was found to be 2.720, 2.514, 2.430, and 2.360 μ coulomb/j, respectively, with errors in the range 1.8 to 2.0%. The calibration of the Edwards-Kerst copper ionization chamber was also checked in this energy range by a comparison method. (auth)

25655 SPECTROSCOPY OF CRYSTALS ACTIVATED WITH MERCURY-LIKE IONS. III. OXYGEN- AND FLUORIDE-CONTAINING PHOSPHORS. N. E. Lushchik and I. A. Muuga. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 21, 61-71(1962). (In Russian)

Indium-activated Ca, Sr, and Ba orthophosphate phosphors, calcium halophosphate, and simple ionic CaO and KF crystals were synthesized. The spectral characteristics of phosphors were examined and the structure of In^+-centers of oxygen- and fluoride-containing compounds was investigated. (auth)

25656 RECOMBINATION LUMINESCENCE SPECTRA IN KCl CRYSTALS ACTIVATED WITH MERCURY-LIKE IONS. I. V. Yaek and M. F. Okk. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 21, 96-116(1962). (In Russian)

By means of photoelectric methods, recombination luminescence spectra (spectra of optical flash stimulated in the F-band, thermoluminescence, and phosphorescence) in KCl(Ga), KCl(In), KCl(Tl), KCl(Sn), and KCl(Pb) phosphors previously excited with x rays were measured. It is shown that the spectral composition of electronic recombinational luminescence corresponds in the main to the activator ions in phosphors activated both by monovalent (Ga^+, In^+, Tl^+) and bivalent (Sn^{2+} and Pb^{2+}) ions. In the hole stages of the relaxation processes (in the temperature range of 100 to 150°K) thermoluminescence of KCl(In) and KCl(Ga) phosphors involves emission of In^+ and Ga^+ ions. No luminescence of Tl^+ ions in KCl(Tl) phosphor in this region was observed. In phosphors with several types of emission centers [KCl(Tl) and KCl(In,Tl)] complex redistribution of emission band intensities was observed during the relaxation processes. After uv excitation of the KCl(In,Tl) phosphor in the $^1S_0 \rightarrow {}^1P_1$ absorption band of In^+-ions only indium radiation could be detected in thermoluminescence. Some aspects of the mechanism of the transfer of recombination energy to emission centers are discussed. (auth)

25657 ELECTRON EMISSION AND RECOMBINATION LUMINESCENCE OF ALKALI HALIDE SALTS EXCITED BY ULTRAVIOLET RADIATION. Kh. F. Kyaembre. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 21, 173-94 (1962). (In Russian)

It was established that excitation of RbBr and CsBr by uv light in the first fundamental absorption band (exciton band) region creates centers in crystals that give an external photoeffect when stimulated by visible light (photostimulated electron emission, PSE). In CsBr such excitation is followed by relatively strong afteremission (AE). The excitation spectrum of AE closely coincides with the first fundamental absorption band and is very similar to the excitation spectra of PSE. It was concluded that the main PSE centers are F-centers. The stimulation spectra of PSE give evidence that the efficiency of PSE is very low in the region of the F-band and rises sharply to the spectral region of direct optical ionization of F-centers. Centers giving strong AE and PSE centers are also created through the excitation of Tl-centers in RbCl(Tl) to $^1P_1$-levels. The PSE stimulation spectrum suggests a direct optical ionization mechanism of PSE also in the case of RbCl(Tl). The decay curves of AE and of the afterglow of Tl-luminescence coincide with great exactness. Discussion on the mechanisms of PSE and AE is also presented. (P.C.H.)

25658 MEASUREMENTS OF SOFT X-RAY EMISSION BY MEANS OF SECONDARY-ELECTRON MULTIPLIERS. A. P. Lukirskii, M. A. Rumsh, and I. A. Karpovich (Leningrad State Univ.). Zavodsk. Lab., 29: 456-9(1963). (In Russian)

The performance of an open-type secondary electron multiplier in measuring soft and ultra-soft x radiation was analyzed, and necessary conditions for absolute intensity measurements were found. Quantum yields of various cathodes are tabulated. (tr-auth)

25659 GEIGER COUNTERS FOR RECORDING SOFT AND ULTRA-SOFT X RADIATION. A. P. Lukirskii, M. A. Rumsh, and N. A. Karpovich (Leningrad State Univ.). Zavodsk. Lab., 29: 495-6(1963). (In Russian)

A gas-filled Geiger counter, designed for recording 23.6 to 280 Å and 1.5 to 18.3 Å x-ray emissions, is described. Coaxial construction with a narrow side window distributed along the generatrix excludes dead regions. The counter efficiencies for various wave lengths are included. (R.V.J.)

25660 PARTICLE SPECTROMETERS WITH HIGH TRANSMISSION, DISPERSION AND RESOLUTION. Helmut J. Liebl (to Geophysics Corp. of America). U. S. Patent 3,087,055. Apr. 23, 1963. Priority date Dec. 10, 1958, Germany.

A principle of imaging for energy, mass, and momentum spectrometers is patented. Transmission, dispersion, and resolution can be improved by choosing the focal lengths and geometrical location of the sector fields in such a way that the entrance slit is imaged stigmatically to the collector slit, the bundle of beams forming one axial intermediate image but no radial one. (M.P.G.)

25661 SCINTILLATION COUNTER. Robert J. Omohundro and Donald E. Field. U. S. Patent 3,087,060. Apr. 23, 1963. Filed June 30, 1959.

A scintillation counter is patented, in which a new type of optical cement is used to couple the scintillator to the photomultiplier tube. The cement forms a strong permanent bond with good light-transmitting properties. It is water soluble, so that the scintillator and tube can be separated intact. The cement is an epoxy resin, the polyepoxide of glycerol and epichlorohydrin, which is mixed with a diamine hardener at the time of use. The composition and properties of the cement and its use in scintillation counters are described. (M.P.G.)

25662 SCINTILLATOR. James A. Rickard (to Jersey Production Research Co.). U. S. Patent 3,088,030. Apr. 30, 1963. Filed Dec. 7, 1956.

A scintillation detector adaptable for use in radiation well logging is patented. Earth formations surrounding a borehole are bombarded with neutrons, and the energies of the induced secondary particles are measured to obtain information concerning subsurface formations. The scintillation detector is designed to distinguish between electrical pulses caused by γ radiation and those caused by neutrons. Two photomultipliers are separated by a plurality of scintillating wafers or cylinders. The thickness of the scintillators is less than the path of electrons produced by γ rays, but greater than the path of protons produced by neutrons. The scintillations in adjacent scintillators are detected by different photomultipliers. Therefore electrons have a high probability of being detected by both photomultipliers, and protons by just one. The outputs of the photomultipliers are fed into coincidence or anticoincidence circuits, thereby making it possible to count γ rays in the presence of neutrons, or vice versa. A pulse analyzer measures the amplitude and number of electrical pulses, thereby determining the energy and intensity of the incoming radiation. (M.P.G.)

25663 DETECTION, METERING AND/OR ANALYSIS OF RADIOACTIVE PARTICLES. Robert E . Payne, Martin J. Cohen, and Henry C. Gibson (to Sharples Corp.). U. S. Patent 3,092,723. June 4, 1963. Filed Sept. 24, 1958.

An apparatus is designed for the continuous and rapid detection and analysis of radioactive particles in a gas for their alpha, beta, and gamma activities. The apparatus comprises a centrifugal separator for separating the particles from the gas, a moving film on which the particles are deposited, and detectors arranged along the film for selective detection of the radiation components. (D.L.C.)

25664 PROPORTIONAL COUNTER. Samuel Fine and Charles F. Hendee (to North American Philips Co., Inc.). U. S. Patent 3,092,747. June 4, 1963. Filed Jan. 9, 1959.

A gas-type proportional counter using an inert gas as fill gas has an infinite lifetime but is affected by the afterpulsing effect in which spurious pulses follow the output pulse. This afterpulsing effect may be prevented by adding 3 to 20% by pressure of nitrogen to the inert gas. (D.L.C.)

25665 AUTOMATIC HAND COUNTER. J. R. Mann and A. E. Wainwright (to U. S. Atomic Energy Commission). U. S. Patent 3,093,738. June 11, 1963.

An automatic, personnel-operated, alpha-particle hand monitor is described which functions as a qualitative instrument to indicate to the person using it whether his hands are "cold" or "hot." The monitor is activated by a push button and includes several capacitor-triggered thyratron tubes. Upon release of the push button, the monitor starts the counting of the radiation present on the hands of the person. If the count of the radiation exceeds a predetermined level within a predetermined time, then a capacitor will trigger a first thyratron tube to light a "hot" lamp. If, however, the count is below such level during this time period, another capacitor will fire a second thyratron to light a "safe" lamp. (AEC)

ISOTOPE SEPARATION

25666 (CEA-2270) EFFETS TRANSITOIRES DU SECOND ORDRE DANS UNE INSTALLATION DE SEPARATION ISOTOPIQUE. (Second Order Transient Effects in a Gaseous Diffusion Plant). G. M. Gouligand (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucleaires, Saclay). 1963. 41p.

Perturbations applied to various parameters of an isotope separation plant indicate an average effect on production. The effect is determined for a finite cascade over an infinite reservoir. Perturbations on product flow rate and interstage transports are considered. (auth)

25667 (CEA-tr-A-1231) PROCÉDÉS ET DISPOSITIFS D'EXTRACTION CONTINUE D'EAU ENRICHIE EN DEUTÉRIUM PAR CONCENTRATION ÉTAGÉE EN DEUTÉRIUM ET ÉLECTROLYSE DE L'EAU. (Procedures and Apparatus for the Continuous Extraction of Water Enriched in Deuterium by Stepwise Deuterium Concentration and Water Electrolysis). A. Winsel and E. Justi. Translated into French from German Patent 1,109,653. Nov. 14, 1962. 35p.

A method for the continuous extraction of D_2O-enriched water from natural water is described. A separation column composed of a water electrolysis cell and one or several enrichment cells with anode and hydrogen cathode is the basis of the method. The deuterium-poor water flows through the enrichment cell in the opposite direction to the hydrogen current. Detailed sketches are given of the apparatus used. (J.S.R.)

25668 ISOTOPE SEPARATION WITH ETL MASS SEPARATOR AND ISOTOPIC PURITY OF SOME COLLECTED ISOTOPES. Isao Kohno. Denki Shikensho Iho, 26: 777-82(1962). (In Japanese)

Using the ETL Mass Separator some isotopes of the Mg, Ne, and Kr were collected. Collected Mg^{24} and Mg^{25} were isotopically analyzed by the Mg(p,γ)Al reaction, and Ne and Kr isotopes are analyzed with a mass spectrometer. 100% isotopic enrichment for Mg^{24}, Mg^{25} and Ne^{20}, and 96% enrichments for Kr^{84} and Kr^{86} were obtained. (auth)

25669 THE ISOTOPIC EXCHANGE BETWEEN GASEOUS HYDROGEN AND LIQUID AMMONIA. PART 2. THE KINETICS OF THE EXCHANGE IN A PACKED COLUMN. P. Duranti-Valentini and P. L. Rebora (L.R.S.R. (ENI), Milan). Energia Nucl. (Milan), 9: 621-7(Nov. 1962). (In English)

The isotopic exchange between gaseous hydrogen and liquid ammonia in the presence of potassium amide was examined on laboratory scale in a countercurrent packed column. Tests were run at pressures up to 60 atm and temperatures between −50 and +10°C; the influence of temperature and pressure on the kinetics of the exchange was investigated as well as the effect of the hydrogen dilution with nitrogen and of the potassium amide concentration in the liquid phase. (auth)

25670 A NEW ION SOURCE FOR ELECTROMAGNETIC ISOTOPE SEPARATORS. J. H. Freeman (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Instr. Methods, 22: 306-16(Apr. 1963). (In English)

A versatile, high-resolution, electron-impact ion source for electromagnetic isotope separators is described. In contrast to conventional ion sources, the performance is excellent over a very wide range of operating conditions. The source efficiency is high and the extracted ion beams appear to be virtually "hash" free. A resolving power of over 13,000 and isotopic enhancement factors of from 10,000 to 30,000 were obtained at outputs of over one milliampere with a variety of elements. Such enrichments are from ten to several hundred times better than those obtained under similar conditions with other sources. The behavior of the source with a number of stable elements and with plutonium is described in detail. The use of carbon as an alternative source filament material is described. (auth)

25671 FACTORS AFFECTING FOCUS IN ELECTROMAGNETIC ISOTOPE SEPARATORS. J. H. Freeman and W. A. Bell (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Instr. Methods, 22: 317-23(Apr. 1963). (In English)

A description of the effect of insulating layers and ion beam defining vanes on the resolving power of electromagnetic isotope separators is given. The consequence of these effects on the design of separators is discussed. (auth)

25672 DEUTERIUM ENRICHMENT IN THE DISTILLATION OF AMMONIA. Gerald T. Petersen and Manson Benedict (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 15: 90-7(Jan. 1963).

The relative volatility or separation factor for deuterium enrichment in ammonia distillation was measured at pressures of 250, 375, 500, 600, and 760 mm Hg and at deuterium concentrations of 0.10, 0.24, 0.42, and 0.58 mole fraction deuterium. The measurements are summarized by the following equation: $\ln(\alpha) = (0.0395 \pm 0.0004) - (0.0128 \pm 0.0029)(x - 0.424) - (0.01246 \pm 0.00065)(\ln\pi/760\ \text{mm Hg})$, where α = separation factor, π = system pressure mm Hg, and x = mole fraction deuterium. It is interesting to note that a dependence on the composition was observed. This is not predicted by the normal method of calculating the separation factor from the vapor pressure ratio $\alpha = \sqrt{P_{NH_3}/P_{ND_3}}$. However, the magnitude of the separation factor and its dependence on pressure are in good agreement with the vapor pressure ratio predictions ($\alpha = 1.042$ at 1 atm). This information is helpful in predicting costs of heavy water production by ammonia distillation. It has been stated by Barr and Drews that ammonia distillation would be competitive with other developed methods only if the actual separation factor was at least 1.062 at low deuterium concentration. Since the separation factor observed was only 1.042 at atmospheric pressure, ammonia distillation is not an economic method for producing heavy water. Deutero-ammonia was synthesized by isotopic exchange between natural ammonia and heavy water. Equilibrium determinations were made using an Othmer still modified for low temperature operation. The ammonia samples were analyzed for deuterium content by converting them to water by passage over hot copper oxide, followed by a differential density determination using the falling drop method. (auth)

25673 A DIRECT METHOD OF CALCULATING THE OPTIMUM OPERATING CONDITIONS OF ISOTOPE SEPARATION COLUMNS. I. E. Bock (F.O.M. Laboratorium voor Massascheiding, Amsterdam). Z. Naturforsch., 18a: 465-72(Apr. 1963). (In English)

The separative power of an infinitesimal countercurrent element is expressed in terms of radial parameters. It is shown that the separative power is independent of the value of the radial product stream. Arbitrarily choosing this to be zero (i.e. "balanced diffusion") makes it possible to

calculate the optimum radial isotope velocities and the axial profile directly from the diffusion and continuity equations. As an illustration of the method, the optimum axial flow profiles and maximum separative powers of gas centrifuges and thermal diffusion columns were calculated and compared with known results. In the case of the gas centrifuge, the effect that axial back diffusion has on the optimum profile and maximum separative power was calculated. The variation of the separative power with different axial profiles was determined for the thermal diffusion column. It appeared that the natural convection induced axial profile, which is used in thermal diffusion columns, gives a small fraction of the maximum separative power. Calculations indicated that a column with a static separative region (and boundary flows) will approach the maximum separative power and will be well suited for measurements of collision parameters. (auth)

25674 THE ISOTOPIC SEPARATION OF CARBON BY ION EXCHANGE. Charles Nelson Davidson. Thesis, Tallahassee, Florida State Univ., 1962. 87p.

The feasibility of using ion-exchange displacement chromatography to effect resolution of $C^{12}-C^{14}$ mixtures has been investigated. Separation was achieved using an OH^-/HCN/HCl system on strongly basic Dowex 2 × 8 resin in which the heavier C^{14} was concentrated in the HCN (solution phase). In an extended run utilizing this system, C^{14}-cyanide was enriched by a factor of $3\frac{1}{2}$ at the front of the band. Resin decomposition and the concurrent loss of cyanide in extended experiments were responsible for the inability to determine experimentally the separation factor. A second system, employing formate as the carbon-containing ion, was developed to achieve quantitatively the isotopic separation of carbon. Utilizing a CH_3COO^-/HCOOH/HCl system on Dowex 2 in an extended experiment to obtain a high specific separation, C^{14} was enriched by a factor of 2 in the HCOOH solution phase. Resin decomposition was not a problem and the separation factor, K, was subsequently determined to be 1.0041 at 25.5°C where $K = (C^{12}/C^{14})_r/(C^{12}/C^{14})_s$. A rough comparison of the formate and cyanide extended runs suggested ϵ (= K − 1) for the cyanide system to be at least 6 times that for the formate system. It was seen that statistical considerations could explain the direction of enrichment for reported isotopic exchange reactions employing ion exchangers and in the $NH_4OH-NH_4^+$ case could quantitatively predict the separation factor. The influence of resin crosslinkage on the separation factor for the formate system was investigated. The separation factor was found to increase in a series of experiments in which the temperature of the system was decreased from 35.4 to 6.0°C. (Dissertation Abstr.)

25675 PROCESS FOR THE PRODUCTION OF WATER OR HYDROGEN HAVING AN INCREASED DEUTERIUM CONTENT. Erwin Willy Albert Becker. U. S. Patent 3,087,791. Apr. 30, 1963. Priority date Sept. 8, 1954, Germany.

Deuterium exchange reactions between H and water in the presence of a catalyst are employed in a patented process for increasing the deuterium content of water or H. Streams of molecular H and water under superatmospheric pressure are passed countercurrent to each other serially through a hot and cold column in the presence of a catalyst of nickel or the platinum-group metals. The catalyst in aqueous dispersion or colloidal solution is circulated through the columns with the water. H of increased deuterium content can be withdrawn from the circuit as it passes from the hot to the cold column. Water of increased deuterium content can be obtained by continuously withdrawing predetermined proportions from the catalyst circuit as it passes from the cold to the hot column. The liquid is freed from the catalyst, and additional quantities of catalyst sol are added to the circuit. Variations of the process and specific examples are described. (M.P.G.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 24760, 26006, 26021, 26120, and 26200.

25676 (TID-18703) VECTOR PRODUCTS AND SKEW SYMMETRIC MATRICES. J. K. MacKenzie (RIAS. Div. of Martin Co., Baltimore). [nd]. Contract AT(30-1)-2531. 14p.

Vector products are regarded as special linear transformations in the usual presentation of matrix theory. Simple identities are derived to facilitate formal manipulations. The matrix treatment involves only second-order skew symmetric matrices and the Euclidean vector space of three dimensions is used. (C.E.S.)

25677 (UCRL-7196) A FORTRAN PROGRAM FOR CALCULATING X-RAY POWDER DIFFRACTION PATTERNS. Deane K. Smith (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 8, 1963. Contract W-7405-eng-48. 74p.

A computer program was written in FORTRAN to calculate the positions and intensities of x-ray-diffraction maxima that would be expected from a randomly oriented powder sample. The input data are essentially identical to the input used in the Busing, Martin, and Levy (1962) FORTRAN least-squares refinement program. A few additional input cards are required which define the desired limits of the power pattern, the Laue symmetry group, special space group extinctions, and the values necessary for the absorption correction. The program uses the Laue symmetry group of the crystal as a guide and generates all nonredundant Miller indices. Reflections not allowed by the space group are eliminated and the d-spacings for the remaining reflections are calculated. The indices are then ordered on their d-values, and the structure factors are calculated. The structure factors are converted to powder intensities by squaring and applying corrections for thermal motion, multiplicity, Lorentz-polarization effects, and absorption. (auth)

25678 (UCRL-10734) LINEAR COMPUTATION OF FUNCTION APPROXIMATION WITH APPLICATION TO FITTING AND EDITING TWO-DIMENSIONAL DATA. Jonathan D. Young (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 26, 1963. Contract W-7405-eng-48. 7p.

Linear computation of level functional approximations for a discrete function is applied to fitting and editing two-dimensional data with particular emphasis on the case in which the approximating function involves two fewer parameters than the number of points. (auth)

25679 (WAPD-TM-367) THE PEACEMAN-RACHFORD METHOD FOR SMALL MESH INCREMENTS. Willis H. Guilinger, Jr. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Mar. 1963. Contract AT-11-1-GEN-14. 80p.

Methods for obtaining bounds on the accuracy of the Peaceman-Rachford iterative method applied to finite-difference approximations of certain two-dimensional elliptic and parabolic partial differential equations are presented. (C.E.S.)

25680 ADJOINT FUNCTIONS AND ORTHOGONALITY RELATIONS. K. F. Hansen and M. Clark, Jr. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 15: 139-41(Feb. 1963).

Abstract operator methods are used to derive the relations between a function satisfying the generalized eigenvalue problem and its various adjoints. Several orthogonality relations are obtained. (auth)

25681 GENERALIZED QUOTA SAMPLING. Herbert A. Steinberg (TRG, Inc., Syosset, N. Y.). Nucl. Sci. Eng., 15: 142-5(Feb. 1963).

A generalization of quota sampling is described and a quantitative evaluation of its validity is made. (auth)

25682 A NOTE ON THE MATHEMATICAL PROPERTIES OF THE BOLTZMANN EQUATION. W. G. Chambers (Cavendish Lab., Cambridge, Eng.). Proc. Phys. Soc. (London), 81: 877-82(May 1, 1963).

The problem of the uniqueness of solutions of the Boltzmann equation is studied. It is shown that if the kernel possesses certain symmetry properties (which it usually does in the absence of magnetic fields) the equation can be reduced to a form that is non-singular in an algebraic sense, and therefore has a unique solution. This solution also minimizes a functional that is equivalent to the standard variational expression. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

Refer also to abstracts 25519, 28114, 26115, 26118, 26180, and 26182.

25683 (ASD-TDR-62-509(Vol.II)) BERYLLIUM RESEARCH AND DEVELOPMENT PROGRAM. (Nuclear Metals, Inc., Concord, Mass.). Sept. 1962. Contract AF 33(616)-7065. 207p.

Work being done in developing beryllium as an Air Force structural material is summarized. The following information is reported: brazing of beryllium to silver and itself, forge welding, resistance welding and brazing, purification by vacuum distillation, aging and strain aging, quench-aging, mechanical properties, chemical and spectrographic analyses, and yield strength. Fabrication and properties of beryllium–copper alloy are included. (N.W.R.)

25684 (ASD-TDR-63-297) DEVELOPMENT OF CHROMIUM COMPOSITE ALLOY WITH HIGH TEMPERATURE OXIDATION AND EROSION RESISTANCE. James F. Masterson (Bendix Corp. Bendix Products Aerospace Div., South Bend, Ind.). Apr. 1963. Contract AF33(657)-8422. 138p.

The effects of extrusion and rolling variables on the quality and mechanical behavior of a powder metallurgy chromium-magnesium oxide composite were studied. Hot rolling at 2200°F and finish rolling at 900°F with reductions of 40 to 55% provided sound, contamination-free sheet having a ductile-brittle transition temperature of 45°F in the recrystallized condition. Oxidation, erosion, and nitridation behavior were observed to be improved over unalloyed Cr. Preliminary studies indicated that a strain aging phenomenon may be responsible for the brittle behavior observed with as-rolled and stress-relieved sheets. The results indicate that the full potential of Cr composites can be realized with additional development directed toward strengthening, and further retardation of nitrogen diffusion at elevated temperature. (auth)

25685 (BMI-1624(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING MARCH 1963. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1963. Contract W-7405-eng-92. 80p.

Development progress is reported on reactor materials and components, fuel fabrication and irradiation testing, radioinduced graft polymerization, radioisotope applications, fuel coating deposition and testing, creep and corrosion testing of materials, fission product deposition, bonding developments, and fission gas release. (N.W.R.)

25686 (EUR-116.d) HERSTELLUNG VON UO_2–UND UO_2–BeO-MISCHPELLETS. (Manufacture of UO_2- and UO_2–BeO Mixed Pellets). Final Report. (Battelle Institut e. V., Frankfurt am Main). Oct. 1962. 25p.

Investigations were made on the preparation of sintered UO_2 and UO_2 with additions of BeO, manufacturing conditions, thermal expansion of sintered bodies up to a temperature of 1100°C, and their thermal conductivity up to a temperature of 1000°C as a function of the BeO addition. Test specimens of UO_2 and UO_2 with additions of 5, 10, 15, and 20% BeO by volume were prepared by cold-pressing, without using binders or lubricants, and subsequent sintering in hydrogen atmosphere at a maximum temperature of 1600°C. The density of the sintered bodies amounted to 95% of the theoretical density of the corresponding mixture. It differed by a maximum of ±0.4%. The thermal conductivity was measured by determination of the amount of heat supplied and the radial heat flow. The results show an increase in the thermal conductivity with increasing BeO content. The addition of 20% BeO by volume caused duplication of the thermal conductivity related to that of pure UO_2. Thermal expansion was measured in a vertical experimental arrangement. The results do not show a well defined dependence of the thermal expansion on the BeO content. Small fluctuations of the measured values are within the range of accuracy of measurement of $\pm 0.2 \times 10^{-6}$ cm/°C. The structure of the individual sintered bodies was examined by microscopic inspection of polished sections. (P.C.H.)

25687 (GA-4173) INVESTIGATIONS OF CARBIDES AS CATHODES FOR THERMIONIC SPACE REACTORS. Quarterly Progress Report for the Period Ending February 28, 1963. L. Yang, A. F. Weinberg, F. D. Carpenter, N. Elsner, R. G. Hudson, J. R. Lindgren, and M. H. Horner (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 15, 1963. Contract NAS 3-2532. 133p.

Studies are being made of the vaporization and electron emission of UC–ZrC and W-clad UC in cesium vapor. Short-term (43 hr) measurements demonstrated that cesium at a pressure of 1.8 torr reduced the rate of vaporization of a 90 UC–10 ZrC sample at 2093°K by about a factor of 6. The effects of sample density were studied. The thermionic-emission microscope was assembled and tested. A high-temperature furnace was fabricated and tested. An integral test of one instrumented and fueled subassembly of the unclad carbide capsule was carried out successfully in the TRIGA Reactor. Clad capsules are being prepared. Measurements were made of the vacuum emission and rate of vaporization of $UMoC_2$. Studies were made of the diffusion between UC and cast tungsten and W–Mo alloys at 1800°C for a period of 24 hr. Methods of hydriding and carburizing U–Zr alloys to prepare submicron-size UC–ZrC powder are discussed. (M.C.G.)

25688 (GEMP-177A) HIGH-TEMPERATURE MATERIALS AND REACTOR COMPONENT DEVELOPMENT PROGRAMS. VOLUME I. MATERIALS. Second Annual Report. (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Feb. 28, 1963. Contract AT(40-1)-2847. 199p.

Progress is reported on development programs for: materials for fuel and for non-fuel high-temperature reactor structural uses; radiation effects on high-temperature alloys exposed to neutron environs to 870°C and 10^{19} nvt; radiation effects on BeO as a function of composition, grain size, density, porosity, and irradiation temperature and dosage; and long-term irradiation testing of 80Ni–20Cr fuel specimens in air at 700 to 815°C. (B.O.G.)

25689 (NMI-2115) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report, February 1963. (Nuclear Metals, Inc., Concord, Mass.). Apr. 23, 1963. Contract AT(30-1)-2784. 21p.

Zone refining was completed on a 6-pass beryllium crystal. Machining of 6 compression samples of various purity levels was completed, and compression tests were made on 4 of these specimens. Machining also progressed on tensile and resistance ratio specimens from a 12-pass zone-refined crystal. Nb–2 at.% Re and Nb–5 at.% Re alloys were successfully hot rolled at 1000°C to 0.1-in. strip and Ta and Ta–2 at.% Ru were cold rolled to 0.05-in. strip. Hardnesses of Mo and Ta alloys were measured at 1000, 1100, and 1200°C. In work to develop uranium-base alloys strengthened by SLIS techniques, approximately 200 g of splatcooled U–1.2 wt % Cu were hot consolidated and a preliminary metallographic and hot-hardness evaluation carried out on the consolidated product. A workable process was developed for extruding tungsten tubing to size. (M.C.G.)

25690 (NYO-10472) SYNTHESIS OF SEMICONDUCTOR MATERIALS USING NUCLEAR RADIATION. Final Report. Kalman Held and Richard J. Goldman (TRG, Inc., Syosset, N. Y.). Jan. 1962. Contract AT(30-1)-2392. 63p. (TRG-132)

The gamma radiolysis of silane was conducted at –195 to 450°C in static and dynamic systems at various pressures. In-pile irradiation were conducted at 100 to 275°C. G values for the decomposition of silane of from 3000 to 35,000 were achieved at high pressure. Qualitative evaluation of some of the deposited silicon reveals material having 10 to 400 ohm cm resistivities. (auth)

25691 (RBESO-3404-2) CERAMIC-TO-METAL SEALS FOR HIGH-TEMPERATURE THERMIONIC CONVERTERS. Quarterly Technical Report No. 2. (Bendix Corp. Red Bank Div., Eatontown, N. J.). Apr. 15, 1963. Contract AF33(657)-10038. 54p. (AD-402679)

Seals capable of long life at 1500°C in cesium and vacuum environments are developed. Improved methods of sealing both metallized and unmetallized ceramic members to refractory metals are developed. Associated work on ceramics, refractory metal alloys, and ceramic-metal composites is made. (auth)

25692 (TID-7654) CERAMIC-MATRIX FUELS CONTAINING COATED PARTICLES. Proceedings of a Symposium Held at Battelle Memorial Institute, November 5 and 6, 1962. (Division of Reactor Development, AEC and Battelle Memorial Inst., Columbus, Ohio). 500p.

Eighteen papers and 10 summaries of papers presented at a Symposium on Ceramic-Matrix Fuels Containing Coated Particles are given. Separate abstracts were prepared for 15 papers. Three papers were previously abstracted for NSA. (M.C.G.)

25693 (TID-7654(p.1-9)) COATED-PARTICLE FUELS FOR CIVILIAN GAS-COOLED REACTORS. R. E. Pahler (Division of Reactor Development, AEC).

The program for coated-particle fuel and the various applications for this fuel in gas-cooled reactors are discussed. A comparison of gas-cooled reactors and saturated-water systems is presented. Possible applications of gas-cooled reactors using coated-particle fuel in production of electricity are also discussed. Fuel element design modifications are described. (M.C.G.)

25694 (TID-7654(p.10-70)) BATTELLE STUDIES OF CERAMIC-COATED PARTICLE FUELS. R. W. Dayton, J. H. Oxley, and C. W. Townley (Battelle Memorial Inst., Columbus, Ohio).

Progress in the program for studying coated-particle fuel materials, in identifying the principles governing the performance of these materials, and in determining combinations of material giving optimum performance is reported. Methods were found for depositing impermeable alumina, beryllia, and magnesia and pyrolytic carbon coatings on particles of fuel materials. Methods for making ideal dispersions of these in graphite and oxide matrices were also developed. In radiation studies it was found that the oxide-coated materials retain their imperviousness to fission products if used at an elevated temperature, but fail almost instantly at low temperatures owing to cracking from radioinduced strain. Carbon-coated materials are able to resist cracking for a longer time, but then fail at either high or low temperatures. The effects of adding void space within the coated particle is being studied to determine whether this prevents failure. (auth)

25695 (TID-7654(p.71-141)) COATED-PARTICLE FUEL DEVELOPMENT AT OAK RIDGE NATIONAL LABORATORY. W. O. Harms, comp. (Oak Ridge National Lab., Tenn.).

Investigations were made of pyrolytic-carbon-coated carbide fuel particles in a graphite matrix under simulated power reactor conditions, particularly with regard to fission-product retention. The potential of coated-particle fuel materials, involving both oxide and pyrolytic carbon coatings, in a variety of liquid coolants was studied. The effects of gamma irradiation were determined. Methods for chemical processing of graphite-matrix fuels containing both carbon- and alumina-coated particles were investigated on a laboratory scale. The methods include "grind-leach" combustion-dissolution, the hot nitric acid process, anodic disintegration, and chloride volatility. Fission-product retention was better by carbon-coated particles in which the coating had a duplex structure than for laminar or columnar structures. It was found that coated-particle fuel elements can be fabricated without excessive damage to the particle coatings and that they meet acceptable specifications with respect to dimensions, fuel loading, bulk- and net-carbon density, and rupture strengths. Combustion-dissolution is considered the best method for processing graphite-base coated-particle fuels. (M.C.G.)

25696 (TID-7654(p.288-304)) COATED FUEL PARTICLE DEVELOPMENT AND EVALUATION. C. C. Browne and R. E. Latta (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati).

A program is being carried out to prepare coated fuel particles less than 50 μ in diameter and to evaluate them in ceramic matrices for possible fuel-element application. Spheroidization of powders with melting points up to approximately 3300°C, vapor-process deposition of alumina coatings on spheres down to 44 μ in diameter, preparation of sols, and incorporation of sol materials in ceramic matrices to yield sintered bodies with good high-temperature stability are described. (M.C.G.)

25697 (TID-7654(p.311-15)) CERAMIC COATED PARTICLES AND GRAPHITE MATRIX FUELS. H. G. Sowman (Minnesota Mining and Mfg. Co., St. Paul).

Work on spherical control particles and fuel particles and on graphite-matrix fuels is described. B_4C particles in sizes ranging from 30 to 500 μ or larger were fabricated and coated with pyrolytic carbon. Spherical particles of $(ThU)C_2$, UC, and UC_2, coated with pyrocarbon, were prepared and their microstructure studied. (M.C.G.)

25698 (TID-7654(p.319-33)) PYROGRAPHITE COATING OF NUCLEAR FUEL PARTICLES. M. P. Lepie (Raytheon Co. Research Div., Waltham, Mass.).

Gas cooled nuclear reactors are designed to use fuel elements of UC_2 and/or ThC_2 spherical powders. The stability of these powders is enhanced by coating them with a refractory, impervious film. Two methods are discussed for the deposition of pyrolytic graphite or carbide coatings. Also treated are methods for spheroidization of these fine powders. (auth)

25699 (TID-7654(p.334-45)) USE OF COATED PARTICLES IN GRAPHITE MATRIX FUEL ELEMENTS. W. E. Parker (Speer Carbon Co. Research Lab., Niagara Falls, N. Y.).

Research on the use of coated fuel particles in graphite matrix elements is described. The concept of the continuous matrix unfueled graphite shell is discussed. A series of graphite-matrix fuel elements containing alumina-coated UO_2 particles and pyrocarbon-coated UC_2 particles was prepared. Unfueled shell spherical fuel elements were improved. (M.C.G.)

25700 (TID-7654(p.349-74)) COATED-PARTICLE FUEL FOR THE DRAGON REACTOR EXPERIMENT. R. A. U. Huddle, J. R. Gough, and H. Beutler (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England).

A description of the core of the Dragon Reactor is presented with emphasis on the major objectives concerning fuel-element development. Reference is made to the proposed specification for the initial charge in describing the methods chosen for production of the coated-particle fuel assemblies. An experimental fluidized bed employed for all coating studies is described, and the development of the prototype production apparatus is traced through its various stages. Methods used for making composite coatings of pyrolytic carbon/graphite and silicon carbide are discussed, and initial results of the evaluation studies presented. (auth)

25701 (TID-7654(p.375-84)) PREPARATION OF GRANULAR POLYMER–CARBON-COATED NUCLEAR FUEL. Toshikatsu Ishikawa and Tohru Nagaoki (Nippon Carbon Co., Ltd., Tokyo).

Processes for coating uranium dioxide and uranium dicarbide particles with pyrolytic carbon are discussed. When uranium dioxide was suspended by means of a suitable dispersion agent in a monomer of divinylbenzene which was then polymerized, spherical grains of divinylbenzene polymer about 1 mm diameter containing uranium dioxide particles were obtained. Uranium dioxide particles of two sizes, the smaller one several microns in diameter and the larger about 200 microns in diameter, were employed; good results were obtained in both cases. The spherical coated grains obtained were then heat treated to 800°C under controlled conditions to carbonize the divinylbenzene without disrupting the coating. The resulting product was a spherical granular carbon-coated nuclear fuel. Examination under both optical and electron microscopy proved the coating surface to be extremely smooth and good. The alpha radioactivity was found by gas-flow counting to be reduced by the carbon coating to $1/20$ to $1/100$ of the initial value. It was ascertained radiographically that the smaller urania particles were distributed dispersedly in the grains, while when the larger particles were used a ratio of about one urania particle to one grain of polymer was found. When the grains were further heated to over 2000°C in vacuum or in an inert gas, the UO_2 was completely transformed into UC_2, with the carbon coating still intact. Tests showed that the product was stable in humid air and to heat shock. Irradiation tests of the fuel particles are under way. (auth)

25702 (TID-7654(p.385-410)) PRODUCTION OF SPHERICAL URANIUM DIOXIDE PARTICLES AND METALLIC COATING THEREON. Y. Akimoto, T. Suzuki, and C. Ito (Mitsubishi Metal Mining Co., Ltd., Omiya, Saitama Prefecture, Japan).

It was found that high-density spherical UO_2 particles are successfully produced, starting from oil-dispersed UO_3 fine powder. The size of the particles can be varied between 50 and 250 mesh, and 95% theoretical density was attained. No difference from commercial, spherical UO_2 was observed as far as metallic coating practice is concerned. A proposed flowsheet in producing spherical UO_2 particles, utilizing swageable UO_2 pilot plant facilities is presented. (auth)

25703 (TID-7654(p.411-20)) COATED-PARTICLE STUDIES FOR BERYLLIUM OXIDE DISPERSION-TYPE FUELS. P. G. Alfredson and R. C. Cairns (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). (AAEC/TM-176)

A summary is given of progress on coated-particle studies. Conventional equipment is used for making near-spherical particles of UO_2 and $(U,Th)O_2$ as feed material for the coating studies. An alternative process based on melting the particles in a plasma jet, is also described. Anhydrous beryllium chloride is being produced by the chlorination of beryllium metal turnings. Alumina coatings were deposited on UO_2 and $(U,Th)O_2$ particles using vapor-phase hydrolysis of aluminum chloride in a fluidized bed. Runs at temperatures up to 1050°C and coating rates of 1 to 20 μ per hr produced coatings 3 to 65 μ thick. Alumina-coated $(U,Th)O_2$ particles were incorporated into a beryllium oxide matrix by hot pressing. Beryllia coatings were deposited on $(U,Th)O_2$ and UO_2 particles by the hydrolysis of beryllium chloride. (auth)

25704 (TID-7654(p.422-54)) SOME ASPECTS OF HARWELL RESEARCH RELATING TO DISPERSED FUELS. P. Murray (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

Research activities on dispersed fuels are concerned with both carbide and oxide systems. In recent studies attention was given to the investigation of the uranium–carbon diagram both in the monocarbide and dicarbide region. It is shown that hypostoichiometric uranium carbide exists as a metastable solid solution of uranium in uranium monocarbide, depending on the heat treatment conditions. Studies of the effects of oxygen and nitrogen impurities on the relative stabilities of the sesquicarbide and dicarbide cleared up many confusing observations and it is now possible to indicate which is the stable phase at high temperatures under the appropriate conditions. The irradiation behavior of the bulk carbides and oxides is also being followed to high burn-up and the burn-up lengths in which discontinuous phenomena occur are beginning to be indicated. Broad indications are also being obtained of the relative diffusion of gases and other fission products in coated particles and of possible solutions to some of the problems. With oxides, the effects of irradiation on BeO as the structural material appear to be more significant than the behavior of the dispersed fuel and, together with the behavior of BeO under thermal conditions, represent the more important problems in this field. (auth)

25705 (TID-7654(p.456-61)) THE PREPARATION OF GRAPHITE-MATRIX FUEL COMPACTS CONTAINING COATED CARBIDE PARTICLES. D. W. Savage (United Kingdom Atomic Energy Authority. Research Group.

Atomic Energy Research Establishment, Harwell, Berks, England).

Methods of preparing ceramic fuel compacts suitable for use in a high-temperature nuclear reactor were studied. The fuel was coated carbides in a highly graphite matrix. Although a high volume packing of 50% was obtained by conventional techniques of pressing and extruding, the matrix density of pressings at this high loading was rather low. The matrix density of the extruded samples was higher. Methods are being developed to coat individual particles with a thin layer of binder and grist to give them extra protection during fabrication and to ensure a more uniform spacing of particles in the compact. (M.C.G.)

25706 (TID-7654(p.462-81)) CARBON-COATED PARTICLES FOR DISPERSION FUELS. A. Auriol, C. David (Battelle Memorial Inst. International Div., Geneva); G. Kurka, and E. LeBoulbin (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble).

The main results obtained in research on carbon-coated fuel particles are presented. These concern: the preparation of spheroidal particles of UO_2 coated with pyrolytic carbon, the properties of the coatings, and the high-temperature behavior of the particles. (auth)

25707 (TID-7654(p.484-92)) BIBLIOGRAPHY ON CERAMIC COATED-PARTICLE NUCLEAR FUELS. (Battelle Memorial Inst., Columbus, Ohio).

A listing of unclassified literature sources on ceramic coated-particle nuclear fuels is presented. One hundred and thirty-seven references are included. (M.C.G.)

25708 (TID-18766) STUDIES OF ALLOY FORMATION. Annual Report, May 15, 1962 to May 15, 1963. W. E. Wallace (Pittsburgh. Univ.). May 15, 1963. Contract AT(30-1)-647. 34p.

Preparation, magnetic characteristics, structural properties, phase studies, and thermodynamic properties of the rare earths, rare earth hydrides, rare earth nitrides, and rare earth alloys are described. (N.W.R.)

25709 (TRG-Inf.-Ser.-295) BIBLIOGRAPHY ON THE PRODUCTION AND PROPERTIES OF SILICON CARBIDE. U. R. M. Chadwick, comp. (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England). Mar. 20, 1963. 38p.

References (368) are given to books, reports, patents, and journals published from 1948 through August 1962. (P.C.H.)

25710 THE CONTAINMENT OF LIQUID-METAL FUELS AT 500–1000°C. B. J. Thamer (Los Alamos Scientific Lab., N. Mex.). At. Energy Rev., 1: No. 2, 3-36(1963). (LADC-5607). (In English)

Some corrosive effects are illustrated by observations in the area of metal coolants, particularly the alkali metals. This subject and the following areas are discussed: the containment of the Pu–Fe eutectic in tantalum: Pu–Ce–Co alloys in tantalum, molybdenum, and ceramics: Ce–Co alloys in tantalum; Pu–Ce–Ni and Pu–Ce–Cu alloys in tantalum, niobium, and molybdenum; U–Pu–Mn alloys in yttrium and ceramics; U–Mn eutectic in yttrium, tantalum, niobium, and ceramics; U–Cr and U–Fe eutectics in yttrium, tantalum, and niobium; Bi–U alloys in steels, graphite, tantalum, molybdenum, beryllium, and yttrium; Bi–Pu alloys in tantalum, niobium, and molybdenum; alloys of Al–U–Th in yttrium, tantalum, and niobium; Al–U alloys in yttrium, tantalum, niobium, and titanium; and Mg–Th alloys in tantalum and niobium. These subjects were reviewed up to October of 1962. (auth)

25711 BERYLLIUM AS A MODERATOR AND REFLECTOR FOR NUCLEAR REACTORS. H. H. Hausner (Polytechnic Inst. of Brooklyn). At. Energy Rev., 1: No. 2, 99-166(1963). (In English)

Beryllium is considered to be basically an excellent material for moderators and reflectors in nuclear reactors, because of its nuclear properties and many of its other physical and mechanical properties. Although known for a long time, beryllium has been developed into an engineering material only during the last few years. This review covers the latest international information on beryllium both as a metal and as an oxide. It covers the occurrence of beryllium in nature, its extraction and fabrication in the metallic and oxidic form. The physical metallurgy is extensively discussed and special emphasis is given to the important problems of beryllium ductility. Based on the most recent research and development work, physical, mechanical, chemical, and nuclear properties of beryllium and beryllium oxide are described in detail. The behavior of these materials in neutron irradiation is briefly discussed. The application of beryllium or beryllium oxide as a matrix material for dispersion-type fuel elements is described. Examples are given for beryllium materials at present being used in nuclear reactors. Data on metallography are reported and a brief review is given of the health hazards in handling beryllium and how to overcome them. The bibliography contains 99 of the most recent references to the beryllium literature. (auth)

25712 PURIFICATION OF URANIUM BY PROGRESSIVE SOLIDIFICATION. Pierre Poeydomenge, Georges Cizeron, and Paul Lacombe (Ecole des Mines, Paris). J. Nucl. Mater., 8: 138-42(Jan.-Feb. 1963). (In French)

U of electrolytic purity is melted and heated to 1250°C, and held at this temperature for 10 hr in order to drive off the more volatile impurities. The U, which is held in a UO_2 boat, is then slowly and progressively solidified from one end of the boat to the other at a rate of about 5 mm/hr. The U purity following this process is less than that obtained by the floating-zone method, but the progressive-solidification method is faster and simpler than the floating-zone method. (T.F.H.)

25713 CONTROL MATERIALS FOR HIGH TEMPERATURE REACTOR APPLICATIONS, ESPECIALLY MIXTURES OF OXIDES. F. Haessner, G. Petzow, and E. Preisler (Max-Planck-Institut für Metallforschung, Stuttgart). Kerntechnik, 5: 153-6(Apr. 1963). (In German)

Neutron absorbing materials — stable at temperatures above 7000°C — for possible reactor applications are discussed. Material combinations which are relatively inexpensive and which absorb neutrons by (n,γ) reactions are of primary interest. Among the many possibilities it is shown by our own investigations that $Cd_2Ta_2O_7$ and $In_2Ta_2O_9$ and mechanical mixtures of both should be most suitable in this respect. (auth)

25714 PREPARATION OF THE LESS COMMON METALS. A. E. van Arkel (Rijksuniversiteit, Leiden). Pure Appl. Chem., 5: 701-22(1962). (In English)

The nomenclature of "common" and "less-common" metals is discussed briefly. The problems of purification of less-common metals are discussed. The effects of impurities on the properties are described. The preparation of metals by halide reductions and the impurities resulting therefrom are discussed. Finally, the various ways of purifying the metals are described. (D.L.C.)

25715 BERYLLIUM IN MAGNESIUM. Kj. Gundersen. Tidsskr. Kjemi, Bergvesen Met., 22: 211-14(Nov. 1962). (In Norwegian)

The method of preventing oxidation by adding trace elements is discussed. It was found that Be gives the highest degree of protection against oxidation in Mg and Mg alloys. The effects of small amounts of Be on grain and the setting of a convenient Be content in die-cast Mg alloys are discussed. The production of an eutectic Al–Be preliminary alloy with reduced Be losses is described. Some of the binary Mg–Be alloys and their properties are discussed. (D.L.C.)

25716 Mo— LESS-COMMON ALLOYS OF MOLYBDENUM. M. G. Manzone and J. Z. Briggs. New York, Climax Molybdenum Co., 1962. 190p.

A series of comprehensive reviews is presented on the properties and applications of Mo in its less familiar combinations with 50 other elements. These 50 elements include both metals and nonmetals, and range from Al to Zr. Extensive bibliographies are included. (D.L.C.)

25717 VOPROSY OBEZVREZHIVANIYA STOCHNYKH VOD V METALLURGII (Decontamination of Waste Waters in Metallurgy). V. I. Lainer. Moscow, State Publishing House of Scientific-Technical Literature on Ferrous and Non-Ferrous Metals, 1962. 67p.

Metallurgical plant and flotation mill waste decontamination is discussed, and rapid monitoring and disposal methods for poisonous and radioactive materials are evaluated. (R.V.J.)

25718 POROUS METALLIC MEMBRANES AND METHODS OF MANUFACTURING THEM. Gilberte Moutaud (to Commissariat a l'Energie Atomique). U. S. Patent 3,086,860. Apr. 23, 1963. Priority date July 25, 1956. France.

A method of making porous nickel membranes for diffusion barriers is patented. A finely divided nickel or nickel-oxide suspension is mixed with an aqueous polytetrafluoroethylene suspension. A solvent such as alcohol is added, and a coagulate containing the nickel or nickel oxide in homogeneous dispersion in the polytetrafluoroethylene is obtained. The coagulate is formed into a sheet and heated, thereby simultaneously evaporating the polytetrafluoroethylene and sintering the nickel powder to a porous membrane. If nickel oxide is used, the heating also reduces the oxide to nickel powder. (M.P.G.)

25719 ELECTROLYTIC PRODUCTION OF METAL ALLOYS. Harvey L. Slatin (to Timax Associates). U. S. Patent 3,087,873. Apr. 30, 1963. Filed June 15, 1960.

A process for the production of alloys of Ti, Zr, and Hf from their oxides and oxygen compounds by fusion electrolysis is patented. The oxide or oxygen compound is dissolved in an electrolyte containing cations such as Ca and Sr, which are more electropositive than Ti, Zr, or Hf with respect to halogens and O. A solid anode and a liquid metallic cathode containing molten alloying metal are used. During electrolysis, the Ti, Zr, or Hf metal is deposited in the liquid cathode, forming a molten metallic alloy. The design of the electrolytic cell, details of the process, and methods for removing impurities are described. (M.P.G.)

Corrosion

Refer also to abstracts 25161 and 26791.

25720 (BMI-X-234) THE CORROSION OF AN INOR-8 SINGLE-VESSEL HYDROFLUORINATOR-FLUORINATOR. P. D. Miller, E. F. Stephan, W. K. Boyd, W. N. Stiegelmeyer, and F. W. Fink (Battelle Memorial Inst., Columbus, Ohio). May 27, 1963. Contract W-7405-eng-92. 27p.

Studies were made on the behavior of a laboratory-scale vessel constructed from INOR-8 and used in a cyclic manner to dissolve Zircaloy-2 and uranium with hydrogen fluoride, followed by volatilization of the uranium with fluorine. Current flowsheet specifications for initial salt composition, temperature, and gas flow were simulated as closely as possible. Weighable corrosion coupons of INOR-8 along with specimens of four other candidate alloys were also tested. The results indicate considerable promise for INOR-8 as a material of construction for a single-vessel hydrofluorinator-fluorinator. The alloy was resistant at welded areas and was not subject to pitting attack. Corrosion on the vessel wall was relatively low, whereas the attack on the coupons was much higher because of intergranular effects. Results for HyMu-80 and Alloy 79-4 (Ni–Fe) rated both alloys higher than INOR-8. "L" nickel was rated lowest because of a more damaging type of intergranular attack that took place. (P.C.H.)

25721 (DC-60-9-123) CORROSION RATES OF UNCOATED BeO. Report No. 716. J. B. Conway (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Sept. 21, 1960. Contract AT(11-1)-171. 21p.

Theoretical equations for calculating corrosion rates of BeO are discussed and the effects of the important variables are identified. The equations were applied to the L2A-1 Insert and calculated; measured corrosion rates are in excellent agreement. A simplified approximate equation was developed for estimating BeO corrosion rates and is presented in graphical form for convenient application. Measurements of pressure drop increase for uncoated BeO fuel tubes in non-nuclear tests seem to be in accord with the proposed hydrolysis theory. (auth)

25722 (GEAP-3999) CORROSION MECHANISM OF ZIRCONIUM AND ITS ALLOYS— DIFFUSION OF OXYGEN IN ZIRCONIUM DIOXIDE. D. L. Douglass (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 27, 1962. Contract AT(04-3)-189. (EURAEC-455)

The diffusion rate of O in anion-deficient zirconia, $ZrO_{1.994}$, was determined by the interface migration of stoichiometric oxide and is represented by the equation $D = 0.055 \exp(-33{,}400 \pm 3100/RT)$. A comparison was made with other processes that occur in the metal and the oxide. Excellent agreement was noted between activation energies of O diffusion in $ZrO_{1.944}$ and those for parabolic or cubic oxidation in both air and water. It appears that O diffusion in the oxide is rate-controlling during oxidation of the metal. The corrosion and oxidation behavior of Zr and some alloys are discussed in terms of the oxide defect structure and the electric conductivity behavior in the oxide. A speculative mechanism for corrosion transition to linear rates was suggested on the basis of preferential oxidation of a grain boundary metallic phase. The nature of the phase and of its formation and elimination are discussed. (auth)

25723 (IDO-28605) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. EVALUATION OF LONG TERM GAS CORROSION OF HEAT RESISTANT ALLOYS FOR USE AS GAS-COOLED REACTOR FUEL CLADDING. J. S. Brunhouse and G. W. Titus (Aerojet-General Nucleonics, San Ramon, Calif.). Apr. 1963. Contract AT(10-1)-880. 116p.

Seven nickel-based alloys and one austenitic stainless steel alloy were tested for periods up to 10,000 hr at 1750°F and up to 4,000 hr at 1850°F in the ML-1 reference

coolant (99.5 vol% N_2 + 0.5 vol% O_2) and air to evaluate the materials and to provide design data for the selection of the fuel cladding for the ML-1 reactor. Hastelloy X, Inconel 600, Inconel 702, Inconel 604, Hastelloy R-235, G-157, Nichrome V, Nichrome V-Cb, and AISI Type 310 stainless steel were examined for gas corrosion effects and internal microstructural changes after 1000, 2500, 5000, 7500, and 10,000 hr exposure. Samples were evaluated by weight change measurements, oxide penetration measurements, tensile testing, and metallographic examination. X-ray diffraction, x-ray fluorescence, and electron microscope analyses were performed primarily on Hastelloy X. The results showed that Hastelloy X has excellent oxidation and nitriding resistance at 1750°F and this material was recommended for use as cladding for the ML-1 fuel elements. (auth)

25724 (TID-18773) CORROSION OF ZIRCONIUM AND ZIRCALOY-2 IN FUSED NITRATE–NITRITE. Technical Report No. XLIII. Larry LaVon Anderson and George Richard Hill (Utah. Univ., Salt Lake City). Jan. 31, 1963. Contract AT(11-1)-1144. 94p.

The behavior of Zr and Zircaloy-2 in a fused salt mixture of 53% KNO_3–40% $NaNO_2$–7% $NaNO_3$ was studied. Both unalloyed Zr and Zircaloy-2 oxidized during 50-hr exposures in the salt mixture. The oxidation of Zr and Zircaloy-2 in the salt mixture for the temperature range 450 to 600°C was followed by observing increases in sample weight as a function of reaction time. The oxide layer (ZrO_2) was examined by x-ray diffraction and found to be highly oriented on the metal surface. The oxidation process was found to be a linear reaction until a layer of protective oxide was formed on the metal surface. An activation enthalpy of 13.8 kcal/mole was determined for the initial linear oxidation process. After a protective oxide layer was formed on the metal surface the reaction became diffusion controlled. The activation enthalpy for the reaction was determined to be 25.1 kcal/mole. Both Zr and Zircaloy-2 were found to form a black to dark gray oxide layer at 400, 450, 500, 550, and 600°C. The effects of surface preparation and gas phase composition were studied. These factors were found to influence the initial reaction but not the diffusion process. A mechanism is proposed to account for the experimental results and alternate mechanisms are discussed. (P.C.H.)

25725 (WADC-TR-59-575(Pt.III)) OXIDATION OF TUNGSTEN AND TUNGSTEN BASED ALLOYS. E. A. Gulbransen, K. F. Andrew, F. A. Brassart, and P. E. Blackburn (Westinghouse Electric Corp. Research Labs., Pittsburgh). Dec. 1961. Contract AF 33(616)-7888. 67p. (AD-285588)

Experiments on the oxidation of W and a 50 wt % Ta–W alloy are described. The rates of oxidation of W were determined from 1150 to 1615°C in O pressures of 2 to 100 Torr. Very high rates of oxidation or surface recession rates were found above 1200°C. An exponential temperature behavior for the rate of oxidation was found for all of the pressures studied. A heat of activation of 14300 cal/mole was estimated from the data. A study of the effect of pressure on the rate of oxidation showed the following empirical equation could explain the weight loss data, $dw/dt = k p^{1.122}$. Theoretical analysis of the data using the absolute reaction rate theory suggested that the rate of oxidation of W was limited by a mobile adsorption process of O onto a W surface already covered by a surface layer of oxide. Oxidation of a 50 wt % Ta–W alloy was studied over the temperature range of 1068 to 1458°C at 152 Torr pressure. The results showed that a protective scale was formed on the alloy. A special 250 kv electron diffraction camera was developed for the study of the W–gas reacting interface. (auth)

25726 (EURAEC-675) ON THE BEHAVIOR OF ALLOY STEELS IN CHLORIDE SOLUTIONS. I. INFLUENCE OF CHLORIDE AND OXIDIZING AGENTS IN THE PRESENCE OF BICARBONATE. (Brussels. Centre Belge d'Etude de la Corrosion). 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 006-60-3 RDB. 71p. (EUR-34.f). A translation.

An original potentiokinetic device was used to conduct a study on localized electrochemical corrosion and absence of corrosion on several specimens of two chrome-nickel 18/8 alloy steels (types AISI 304 and 316) and a chrome alloy steel (type AISI 410) in the presence of 20°C 0.10 M sodium bicarbonate solutions containing different quantities of sodium chloride. A study was made of the influence exercised by the surface state and heat treatments on the conditions governing the corrosion and absence of corrosion in the steel specimens. The results were utilized on the basis of the Brennert breakthrough potential and the protection potential concepts, to deduce general criteria making it possible to predetermine the circumstances in which oxidizing and reducing actions can cause localized corrosion in such steels, or, conversely, protect them against such corrosion. The validity of the predeterminations was checked by corrosimetric and corrosiscopic tests, during which examinations were made of, on the one hand, the influence of oxidizing substances (hypochlorite, permanganate, hydrogen peroxide, oxygen) and, on the other hand, of the influence of an anodic polarization and a cathodic polarization on the behavior of the steels in the presence of solutions of chloride and bicarbonate. (auth)

25727 (EURAEC-676) ON THE BEHAVIOR OF STEEL ALLOYS IN SODIUM CHLORIDE. II. INFLUENCE OF SODIUM BICARBONATES AND SULPHATES AT 20°C. J. Klimzak-Mathiew, J. Meunier, M. Pourbaix, and C. Vanleugenhague (Brussels. Centre Belge d'Etude de la Corrosion). 1962 Work Performed under United States–Euratom Joint Research and Development Program. Contract 006-60-3 RDB. 24p. (EUR-35.f). A translation.

An original potentiostatic apparatus was used to study the localized corrosion and noncorrosion conditions of 18/8 Cr–Ni austenitic steel (AISI 304) at 20°C in the presence of double-distilled H_2O and $NaHCO_3$, sclutions containing varying quantities of NaCl. The NaCl content causing the passivation film to break was determined for electrode potentials ranging between +800 mv and +100 mv/ecs. It was observed that when NaCl is added to double-distilled H_2O there is no pitting risk at 20°C if the Cl^- concentration does not exceed 9 mg l^{-1}; this critical concentration amounts to 260 mg Cl^- l^{-1} in the case of 0.010M $NaHCO_3$ solution and to 1,260 mg Cl^- l^{-1} in the 0.10M solution. It was also seen that the quality of the passivation film of 304 steel can probably be improved by anodic prepolarization and that the sulfates have a certain protective effect against the corrosive action of chlorides on stainless steel. (auth)

25728 (EURAEC-677) THE BEHAVIOR OF STEEL ALLOYS IN SODIUM CHLORIDE SOLUTIONS. III. INFLUENCE OF TEMPERATURE ON "RUPTURE" AND "PROTECTION" POTENTIALS OF STEELS AND ON SODIUM CHLORIDE CONCENTRATIONS FOR "RUPTURE" AND "PROTECTION" (SODIUM BICARBONATE SOLUTIONS). Special Technical Report. (Brussels. Centre d'Etude de la Corrosion). 1962. Work Performed under United States–Euratom Joint Research and Development

Program. Contract 006-60-3 RDB. 32p. (EUR-36.f). A translation.

By means of an original potentiokinetic installation, an orientation study was undertaken by extending to temperatures of 40 and 80°C a study previously made on the rupture potential and protection potential values of a chromium ferritic steel sample (AISI 410) and two electrolytically polished Cr–Ni and Cr–Ni–Mo austenitic steel samples (AISI 304 and 316 respectively) in the presence of 0.10 M Na_2CO_3 solutions containing varying NaCl contents. Determinations were carried out on the rupture concentrations of chloride below which there is no corrosion of the steels, and also the protection concentrations of chloride below which the pitting that would previously have appeared ceases to develop. It was observed that, in the case of the 304 and 316 austenitic steel samples examined, a temperature rise above 20°C causes a drop in the rupture potential and the protection potential, together with a drop in the rupture concentration and the chloride protection concentration. This unfavorable effect of the temperature is particularly marked in the case of 316 steel, the chloride resistance of which nonetheless remains constantly superior to that 304 steel, which is itself considerably superior to 410 steel. In the case of a 410 ferritic steel sample, a rise in temperature had only a slight effect on the rupture and protection potential and concentration values. It was observed that a temperature rise can have a favorable effect on the behavior of the steel. (auth)

25729 (EURAEC-678) ON THE BEHAVIOR OF STAINLESS STEELS IN SULPHURIC SOLUTION. IV. EXPERIMENTAL RESEARCH. Special Technical Report. (Brussels. Centre Belge d'Etude de la Corrosion). Sept. 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 006-60-3 RDB. 40p. (EUR-37.f). A translation.

An original automatic electronic potentiokinetic and potentiostatic installation was used to determine potential/current potentiokinetic curves and current/time potentiostatic curves relating to three austenitic Cr–Ni 18.8 stainless steels (AISI 304, 316, and 321) and a Cr ferritic stainless steel (AISI 410) in the presence of a 1 M solution of sulfuric acid at 25°C in nitrogen atmosphere. The steels were examined after having been subjected to different heat treatments, in particular, sensitization to intergranular corrosion (2 hr at 675°C) and also, in the case of the 321 steel, immunization against intergranular corrosion (heating for 2 hr at 870°C). The ferritic steel was examined after having undergone treatment including sensitization to intergranular corrosion (heating for 10 minutes at 1°C). The steels were also subjected to various corrosimetric tests including the Strauss copper sulfate test and the Huey nitric acid test, and free immersion tests in a sulfuric solution to which various oxidizing or reducing agents were added. The overall results obtained enable conclusions to be drawn concerning the validity of potentiokinetic and potentiostatic methods for predetermining the corrosion and noncorrosion conditions of stainless steels and for predicting the general or intergranular nature of possible corrosion. (auth)

25730 (EURAEC-679) ON THE BEHAVIOR OF STAINLESS STEELS IN SULPHURIC SOLUTION. V. BIBLIOGRAPHICAL STUDY. C. Mertens (Brussels. Centre Belge d'Etude de la Corrosion). Sept. 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 006-60-3 RDB. 46p. (EUR-38.f). A translation.

A critical review was made of previous data on the behavior of stainless steels in sulfuric solution. 115 references are included. A survey was made of results obtained with electrochemical methods (intentiostatic, potentiostatic, potentiokinetic, and other electrochemical methods), and with classical corrosion testing methods (Strauss test, Huey test, nitrofluorhydric test, and other tests). (P.C.H.)

25731 (JPRS-18939) BIBLIOGRAPHIC INDEX OF USSR WORKS ON CORROSION AND PROTECTION OF MATERIALS. V. V. Krasnoyarskii (Krasnoyarskiy) and F. M. Reznik. Translated from "Korrosiya i Zashchita Materialov — Bibliografiya Otechestvennoi Literatury Za Period s 1917 po 1959 Gody" Moscow, 1961. 130p. (OTS-63-21697).

References (826) are given to Russian journals published from 1917 to 1959. A separate list of journals is included. (P.C.H.)

25732 OXIDATION OF METALS. A. U. Seybolt (General Electric Research Lab., Schenectady, N. Y.). Advan. Phys., 12: No. 45, 1-43(Jan. 1963).

The scientific background of metal oxidation is reviewed. Some of the contributions leading toward an understanding of the mechanisms of oxidation are also reviewed. Suggestions are made relating to needed research in this field. (auth)

25733 CORROSION RESISTANCE OF CHROMIUM–NICKEL STAINLESS STEELS IN SODIUM, AS A FUNCTION OF THE LATTER'S OXYGEN CONTENT. Georgi Ilincev (Akimov State Scientific Research Inst. for the Protection of Materials, Prague). At. Energ. (USSR), 14: 375-82(Apr. 1963). (In Russian)

The action of liquid alkali metals, such as sodium, used as heat transfer agents, on structural materials at high temperatures, is considerably enhanced by the presence of impurities, such as oxygen or carbon. The solubility and the mass transfer processes are greatly accelerated by even very small amounts of O. This problem was studied in dynamic corrosion tests, attempting to determine the changes in the corrosion resistance of Cr–Ni stainless steels as a function of the O content of the Na while simulating the conditions which prevail in nuclear power stations. The tests were carried out in a pilot-plant scale loop, using 1 Cr–18 Ni–9 Ti type stainless steel for fabricating all the portions of the system coming in contact with the liquid metal. The high-temperature portion of the system was operated at 550 ± 5°C; the low-temperature portion at 400 to 420°C. Six different stainless steel specimens were placed in the sodium, the O content of which was kept at 3×10^{-3} and (4 to 5) $\times 10^{-2}$%, maintaining a flow rate of 1.5 m/sec. The results indicated that the corrosion rate of the 18–8 type stainless steels in Na with the higher O content does not exceed 21.3 mg/dm^2/month; this type of steel was found not to be subject to intergranular corrosion and its mechanical properties were only slightly affected. (TTT)

25734 CORROSION RESISTANCE OF STAINLESS STEEL AND ALLOYS IN ORGANIC ACIDS. J. Bourrat (CAFL, Unieux, France). Corrosion Anti-Corrosion, 11: 140-6(Apr. 1963). (In French)

The corrosive properties of the organic acids most commonly used in chemical industry (acetic, formic, lactic, and citric acids) are considered. The conditions under which corrosion of stainless steels and alloys are produced during storage and fabrication are determined. The various corrosion forms of stainless steel are discussed at

some length. It is shown that the transposition of laboratory results on corrosion resistance to practical industrial uses is quite delicate because of the importance of trace impurities in the corrosion mechanisms. (tr-auth)

25735 THE CORROSION BEHAVIOR OF INCONEL NICKEL–CHROMIUM ALLOY AND NIOBIUM ALLOYS IN PRESSURIZED-WATER REACTOR ENVIRONMENTS. Warren E. Berry (Battelle Memorial Inst., Columbus, Ohio). Energie Nucl., 4: 204-16(May-June 1962). (In French)

Corrosion experiments were conducted in simulated primary and secondary reactor waters on Inconel alloy specimens in several conditions of heat treatment and alloy compositions. Exposures to primary water were carried out under static conditions at 150, 288, and 360°C and under flowing reactor coolant conditions at 288 and 343°C. Stress specimens, weldments, and galvanic specimens were included in the study. Experiments on the corrosion behavior of niobium alloys were conducted in static 315 and 360°C water and in 400°C steam at 100 atm. Alloy compositions, exposure conditions, and results are given in tables. (auth)

25736 CONTRIBUTION TO THE ELECTROCHEMICAL BEHAVIOR OF CHROMIUM AND IRON–CHROMIUM ALLOYS IN THE TRANSPASSIVE REGION. Th. Heumann and H. S. Panesar (Universität, Munster, Ger.). J. Electrochem. Soc., 110: 628-33(June 1963).

The polarization curves of Cr in electrolytic solutions containing different anions showed that the anions did not have any influence on the mechanism of dissolution of Cr in the transpassive region and that only OH^- ions take part. The current/potential curves of CrOOH and Cr_2O_3 demonstrated the possibility of the former compound being present in the passive layer. Measurements of the roughness factor of Cr after polarization in the active or the passive state indicated that the roughness of the surface remains constant within the accuracy of this method. The average roughness factor was 1.7. Further surface measurements were carried out on a Fe–Cr alloy (containing 27% Cr), which demonstrated an increase in the roughness of the surface after polarization of the alloy in the primary transpassive region. (auth)

25737 COMPATIBILITY OF MAGNESIUM–ZIRCONIUM ALLOY WITH CARBON DIOXIDE UNDER PRESSURE AT ELEVATED TEMPERATURES. R. Darras, D. Leclercq, and R. David (CEN, Grenoble, France). J. Nucl. Mater., 8: 23-38(Jan.-Feb. 1963). (In French)

The behavior of magnesium–zirconium alloys with 0.4, 0.5, and 0.6 wt. % zirconium was examined at 450, 500, and 550°C in the presence of carbon dioxide at pressures of 15, 25, and 60 atm. For comparison, unalloyed magnesium was examined as well. Weight increases of the alloys were always very slight; the kinetic curves representing these increases were of parabolic form. In practice, the corrosion resistance of these alloys revealed itself to be excellent up to at least 500°C, even if related phenomena such as growth and aging are taken into account, and in spite of the fact that rather irregular but very thin black surface layers are systematically formed. The adoption of these alloys as canning material for the fuel elements of the G_2, G_3, and EDF reactors was thus proved entirely judicious. Moreover, the first two reactors have operated for some years and a negligible number of can failures was recorded. (auth)

25738 COMPATIBILITY OF SINTERED MAGNESIUM WITH CARBON DIOXIDE UNDER PRESSURE AT ELEVATED TEMPERATURES. D. Leclercq, R. David, and R. Darras (CEN, Grenoble, France). J. Nuol. Mater., 8: 41-8(Jan.-Feb. 1963). (In French)

"Sintered magnesium," a material with excellent mechanical properties, was subjected to prolonged exposure to carbon dioxide. Its compatibility with this heat transfer medium is comparable (though slightly less favorable) with that of purely metallic magnesium alloys, and in particular of magnesium–zirconium alloys. Taking into account its dimensional stability, the sintered magnesium can be considered for use up to 500°C at least, even in the presence of graphite. (auth)

25739 THE OXIDATION OF MAGNESIUM ALLOYS IN REACTOR ATMOSPHERES. L. A. Popple (English Electric Co. Ltd., Whetstone, Leicester, Eng.). J. Nucl. Mater., 8: 60-76(Jan.-Feb. 1963). (In English)

Results are given of the oxidation behavior of several magnesium-base alloys in normal reactor atmospheres and some "fault conditions." The alloys A. 12 (Mg–Al–Be), ZA (Mg–Zr), ZW. 1 (Mg–Zr–Zn), and AM. 503(s) (Mg–Mn), chosen because of their possible application as canning or structural materials in a gas-cooled graphite-moderated reactor, oxidize similarly with the production of thin adherent films under normal reactor gas atmospheres, the oxidation rates being very low even at 600°C. The effects of temperature, surface finish, moisture and air content of the CO_2, welding, and stress on the oxidation of these alloys in carbon monoxide–carbon dioxide mixtures were studied in the temperature range 500 to 700°C. The possible reactions contributing to the oxidation process are discussed. (auth)

25740 COMPATIBILITY OF STAINLESS STEELS WITH CARBON DIOXIDE AT ELEVATED TEMPERATURES. H. Loriers, D. Leclercq, and R. Darras (CEN, Saclay, France). Mem. Sci. Rev. Met., 60: 177-88 (Mar. 1963). (In French)

Among the common types of stainless steel, those stabilized with niobium show the greatest resistance to oxidation by carbon dioxide under pressure between 600 and 700°C; they could represent a convenient canning material for fuel elements in advanced nuclear reactors. (auth)

25741 ELECTROCHEMICAL STUDIES OF NIOBIUM AND VANADIUM PASSIVATION. A. Ya. Shatalov, T. P. Bondareva, and L. E. Tsygankova. Zh. Prikl. Khim., 36: 588-94(Mar. 1963). (In Russian)

An analysis was made of the behavior of Nb and V electrode potentials in certain aggressive electrodes with anode polarization. At constant current density the Nb potentials increase with polarization and reach several tens of volts. There was a proportional relation between the amount of passed electricity and the magnitude of the potential regardless of the amount of current applied to the electrode. Electrode potentials of a V anode depend, at ionization regions, on the current density. With an increase of solution pH, polarization curves shift gradually to the negative side. Passivation of V is reached in an alkali solution. (R.V.J.)

Fabrication

25742 (AWRE-O-21/63) TEXTURES IN ROLLED URANIUM SHEET. M. J. C. Hill (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). May 1963. 61p.

Apparatus was developed for the determination of the

(002), (021), and (110) pole figures for U sheet. Pole figures plotted from sheets rolled under various schedules indicated the textures produced and R and K formability tests showed the effects produced by the textures on the deep-drawing properties of the sheets. Cross hot and warm rolling was found to produce a strong texture that was symmetrical about the sheet normal and that showed little directionality, enabling it to be easily deep drawn. (auth)

25743 (EUR-39.e) ELECTRON BEAM WELDING OF SINTERED ALUMINIUM. M. Meulemans, D. Tytgat, J. Van Audenhove (Mol, Belgium. Centre d'Etude de l'Energie Nucleaire); J. Briola, and P. Jehenson (European Atomic Energy Community Nuclear Research Center, Ispra, Italy). 1962. 19p.

With new sintered and degassed aluminium products (SAP-ISML), it was possible to obtain successful closure of tubes grades SAP–ISML 960, 930, and 895. High-temperature testing under pressure was used to verify the quality of the welds. Use of external pressure on the tube during welding led to high quality closures equal to or superior to other types of welds because of the very high, localized heating. Electron beam welding can also be systematically used as a quality test for gas content in the material. (P.C.H.)

25744 (HW-77291) THE DEVELOPMENT OF A DRAWING LUBRICANT. Frank B. Quinlan (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 16, 1963. Contract AT(45-1)-1350. 12p.

The development of a high-melting-point (238°F) asphalt lubricant for metal working that is used to protect exotic and refractory metals from scoring during cold forming operations is described. The first coat of the lubricant is very thin as well as being inexpensive to apply and to remove. In some cases, the initial application of the lubricant will last through several deforming operations such as successive wire drawing reductions or tube sinking passes. (P.C.H.)

25745 (NYO-9329) BIMETALLIC CASTING. Final Report. Thomas Poole and David Krashes (Worcester Polytechnic Inst., Mass.). Sept. 1, 1962. Contract AT(30-1)-2557. 25p.

Uranium and Zr were bonded by melting the two metals in contact with one another in a bimetallic casting process. Tensile tests of specimens containing the original zone of interface between the two metals showed that all failures were at locations other than the interface. The coefficients obtained for diffusion between molten U and molten Zr varied from 2.13 cm^2/day at 3380°F to 9.17 cm^2/day at 3510°F. The activation energy for the diffusion process was calculated to be 182,000 cal/g mole. (auth)

25746 (ORNL-TM-588) A NEW PROCESS FOR THE REMOTE PREPARATION AND FABRICATION OF FUEL ELEMENTS CONTAINING URANIUM-233 OXIDE–THORIUM OXIDE. O. C. Dean, R. E. Brooksbank, and A. L. Lotts (Oak Ridge National Lab., Tenn.). June 10, 1963. Contract W-7405-eng-26. 40p.

A remotely operated pilot plant for the engineering development of the sol-gel—vibratory-compaction procedure is being used to prepare about a thousand Zircaloy-2-clad fuel elements for a zero-power criticality experiment. The feasibility, safety, and economy of remote recovery, preparation, fabrication, and inspection of $U^{233}O_2$-ThO_2 fuels are being evaluated. The procedure includes solvent extraction recovery of U^{233} by means of di-sec-butyl phenylphosphonate in diethylbenzene; the sol-gel process, a new procedure for preparing dense oxide fuels; oxide particle sizing; vibratory compaction loading of fuel tubes, followed by end-closure welding, cleaning, and inspecting. Gamma-ray scanning will be used to determine the uniformity of the fuel density. Instruments are provided for remote control of the process and for monitoring the radioactivity and evaluating the hazards to workers at each step of the operation. Twelve pilot-plant runs involving uranium decontamination, sol-gel preparation of 50 kg of oxide, and fuel sizing and classification were completed, with only minor difficulties. The results of examination after irradiation of 17 test capsules at burnups to 17,000 Mwd/metric ton of fuel showed the sol-gel-prepared oxide to perform satisfactorily with respect to stability and fission gas release. In laboratory experiments, uranium-thorium dicarbide fragments and microspheres were prepared by the sol-gel process at a maximum temperature of 1600°C. (auth)

25747 (SCDR-82-63) THE SPUTTERING OF CADMIUM COATINGS ON STEEL. D. M. Mattox and J. E. McDonald (Sandia Lab., Albuquerque, N. Mex.). Apr. 1963. Contract [AT(29-1)-789]. 9p.

A technique for the sputtering of Cd coatings on steel is described. Results show that sputtered Cd coatings are more adherent to mild steel than are coatings deposited by thermal evaporation techniques. The procedure shows promise where Cd coatings are desired on high strength steels where H embrittlement is a problem. (auth)

25748 (TRG-Report-537) INVESTIGATION INTO THE GEOMETRY OF GAS PORES IN TITANIUM BUTT WELDS. H. Jackson and G. R. Kirkland (United Kingdom Atomic Energy Authority. Reactor Group, Culcheth, Lancs, England). Apr. 22, 1963. 7p.

A number of Ti butt welds were examined radiographically and metallographically and the results indicate that the gas pores are spherical, thus giving a greater loss of wall thickness than that indicated by the projected area of the image. It was concluded that the maximum size of porosity specified for acceptance may be safely assessed from the radiograph. (P.C.H.)

25749 (WANL-PR-(N)-001) DEVELOPMENT OF HIGH STRENGTH COLUMBIUM AND TANTALUM ALLOY TUBING. First Quarterly Progress Report, December 1, 1962–February 28, 1963. R. W. Buckman, Jr. (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Apr. 11, 1963. Contract AT(30-1)-3108. 17p.

A program for the evaluation of the extrudability of B-66 (Nb–5V–5Mo–1Zr) and T-111 (Ta–8W–2HF) alloys for tubing is outlined. Starting billets are being clad in mild steel and will be extruded within the 2000 to 2200°F temperature range. The tube blank size of 2-in. OD × ¼-in.-thick wall will be extruded from a 4.22-in.-OD × 1.30-in.-thick wall starting billet. (P.C.H.)

25750 CERAMIC ADHESIVE BONDING OF REFRACTORY METALS—A PRELIMINARY INVESTIGATION. Ray K. Reeder, Jr. and Roger A. Long (Narmco Research and Development Telecomputing Corp., San Diego, Calif.). Am. Ceram. Soc. Bull., 42: 337-9(June 7, 1963).

The feasibility of utilizing ceramic adhesives for the refractory metals molybdenum, tungsten, tantalum, and niobium was demonstrated. The tantalum pentoxide (Ta_2O_5)-based glasses showed promise as adhesives for vacuum joining of tantalum and niobium, and with base-metal oxide additions they formed, in vacuum, good bonds between molybdenum coupons and between tungsten coupons. The eutectic compositions of the refractory oxides alumina,

titania, magnesia, silica, and zirconia wet and adhered to the various refractory metals, thus forming adhesive bonds. These compositions were the most promising adhesives studied. (auth)

25751 THE TECHNOLOGICAL CONDITIONS FOR THE FABRICATION AND TRANSFORMATION OF MAGNESIUM–ZIRCONIUM ALLOYS AND THEIR METALLURGICAL PROPERTIES. J. Hérenguel (Centre de Recherches de la Société Trefimétaux, Antony, France). J. Nucl. Mater., 8: 12-22(Jan.-Feb. 1963). (In French)

Part of the studies and developments which led, in France, to the choice of Mg–Zr materials for the canning in the reactors cooled with CO_2 are summarized. Problems relating to foundry and to fabrication are outlined as well as the essential properties of the material itself, concerning grain-size stability and the properties for long-time heating. Some results regarding internal hydriding and notably better creep resistance are mentioned. (auth)

25752 FABRICATION, TRANSFORMATION, AND METALLURGICAL PROPERTIES OF COMPOSITE MATRICES OF THE TYPE Mg–MgO. J. Hérenguel (Centre de Recherches de la Société Trefimétaux, Antony, France). J. Nucl. Mater., 8: 49-59(Jan.-Feb. 1963). (In French)

Studies carried out on the composite Mg/MgO, the applications of which are considered for nuclear materials, are discussed. The principles of fabrication are enumerated from treatment of oxidation (or of fluorination) to the final extrusion into bars, extruded sections, tubes, etc. The essential properties of the material are given, especially those regarding hardening (at room and high temperature) and the stability of the structure and of the properties for high temperature uses. (auth)

25753 THE BONDING OF S.A.P. R. Akeret (Aluminium-Industrie-AG, Neuhausen am Rheinfall, Switzerland). J. Nucl. Mater., 8: 126-37(Jan.-Feb. 1963). (In English)

By reason of the special structure of SAP, achieved by powder metallurgy, the conventional fusion welding methods are unsuitable for this material. Methods of solid-state bonding such as flash butt welding or hot pressure welding were successfully applied to SAP. Under suitable conditions it should nevertheless be possible to achieve bonds satisfactory for many practical purposes by adopting such fusion welding techniques as will allow the material to be melted only within extremely close-drawn limits as to time and area. (auth)

25754 SINTERING OF UO_2 IN CARBON DIOXIDE ATMOSPHERE. I. Amato, R. L. Colombo, and A. M. Protti (FIAT. Sezione Energia Nucleare, Turin). Nucl. Sci. Eng., 16: 137-40(May 1963).

Sintering of depleted UO_2 powders in CO_2 and H_2 was carried out and the resulting densities compared. The results show that CO_2 sintering reduces both the temperature and time required for attaining a certain fired density. The effects of organic additions to the powder on the final density were also studied. (D.L.C.)

25755 SINTERING OF URANIUM OXIDES. Gunnar Jakobsen (Institutt for Atomenergi, Lillestrøm, Norway). Tidsskr, Kjemi, Bergvesen Met., 23: 49-57(Mar. 1963). (In Norwegian)

A description is given of a pilot plant for the manufacture of sintered UO_2 pellets from oxide powder. The reasons for selection of equipment and methods are given. Control methods and specifications are discussed. Comments are made on safety measures and health control. (auth)

25756 TRANSACTIONS VACUUM METALLURGY CONFERENCE 1962. Rointan F. Bunshah, ed. Boston, American Vacuum Society, 1963. 231p.

Sixteen papers and one general discussion are presented on various topics in vacuum metallurgy: casting, melting, electron beams, brazing, and degassing. Separate abstracts were prepared for ten of the papers; one of the remaining papers was previously abstracted in NSA. (D.L.C.)

25757 THE CENTRIFUGAL CASTING OF URANIUM TUBES IN A VACUUM. Herbert Davis and Robert L. Schardt (National Lead Co. of Ohio, Cincinnati). p.1-11 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

A description is given of the horizontal centrifugal casting step of an alternate route for the fabrication of U ingots into fuel cores. The difficulties of developing the proper casting techniques in vacuum are outlined. The equipment to be used in centrifugal casting is described. Studies were made on the operational variables (mold design, mold materials, mold coatings, mold rotational speeds, mold temperatures, and metal temperature during pouring), and results are described briefly. (D.L.C.)

25758 VACUUM MELTING AND CASTING OF A ZIRCONIUM–9.3 w/o ENRICHED URANIUM CORE ALLOY FOR THE DRIVER ELEMENTS OF THE HEAVY WATER COMPONENTS TEST REACTOR (HWCTR). A. B. Bremer (Nuclear Metals, Inc., Concord, Mass.). p.12-20 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

Procedures and equipment are described for the fabrication of tubes of a homogeneous core alloy composition for 50 driver elements. The U^{235} loadings per foot length were found to be within the specification of 108 ± 5.4 g. (D.L.C.)

25759 A VACUUM SKULL CASTING TECHNIQUE TO PRODUCE SMALL REFRACTORY ALLOY INGOTS. James R. Doyle and Simon S. Aconsky (Pratt and Whitney Aircraft, Middletown, Conn.). p.29-38 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

The finger casting technique is fast and requires only minimal material and standard laboratory arc casting equipment. It has been used with success in a Cb alloy evaluation program which required a large variety of small amounts of wrought alloys. These castings have generally been fabricable to useful rod and sheet stock using refractory metal rolling and extrusion techniques. (auth)

25760 PREPARATION OF HIGH-TEMPERATURE COMPOUNDS BY VACUUM ARC MELTING. E. L. Foster, N. E. Daniel, R. W. Getz, R. W. Endebrock, and R. F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). p.39-67 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

There is an ever-increasing research effort being devoted to that class of materials generally referred to as high-temperature compounds. Unfortunately, the property determinations and other studies have, for the most part, been performed on material produced by powder techniques. The bodies so produced have been high in impurity content and several percentage points below theoretical density, and there is some question as to the true properties of the materials tested. Vacuum or reduced-pressure arc melting and casting can produce high-density, high-purity materials relatively easily and at surprisingly low cost. In order to illustrate the versatility of the method, experi-

ence in the preparation of compound classes is discussed in some detail. Uranium carbide is produced by vacuum skull arc melting and casting. Examples of the compositional control obtainable, the density achieved, and the structural soundness of the finished castings indicate the value of the process. In addition, some interesting figures on yield and cost are presented. Another potential nuclear fuel, uranium mononitride, has been produced by melting. Because of the various types of starting stock involved and the different properties of the material, a description of the process as it applies to UN points out its versatility. Due to the high dissociation pressure of uranium nitride at its melting point, melting is performed under a gas blanket of nitrogen at 19 atm pressure absolute. Examples of the structures and analysis obtained are used to illustrate the potential of the process. Because of the direct applicability of the modified technique to other materials or compounds with relatively low dissociation pressures, a rather complete description is presented. The third class of materials which is used to illustrate the versatility of the process is the beryllides. The modification of the technique for these materials consisted of a two-step arc-melting process in which consumable-electrode arc melting was combined with inert-electrode arc melting and drop casting of the prealloyed materials to small shapes. These operations are conducted in reduced-pressure atmospheres of inert gas because of the vapor pressure of beryllium. Photographs and photomicrographs of castings indicate the potential of the melting process. (auth)

25761 SOME PROBLEMS RELATED TO THE USE OF HIGH ENERGY ELECTRON BEAMS. H. Gruber, W. Dietrich, E. Erben, J. Heimerl, H. Stephan (W. C. Heraeus GmbH, Hanau, Ger.). p.68-94 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

Some of the problems in the industrial use of electron beams in melting and casting furnaces are outlined together with possibilities for overcoming them. Comparisons are made of four electron beam generating systems. Results of the Heraeus multiple Pierce-type gun melting techniques are given for a wide variety of metals and alloys. (D.L.C.)

25762 EXPERIENCE WITH AND ECONOMICS OF THE MEGAWATT ELECTRON BEAM FURNACE. Hugh R. Smith, Jr. (Temescal Metallurgical Corp., Berkeley, Calif.). p.95-102 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

A description is given of the Temescal Megawatt Electron Beam Furnace and its operation. The various applications and economics of operation are discussed briefly. (D.L.C.)

25763 ELECTRON BEAM WELDING OF TUNGSTEN AND MOLYBDENUM. H. S. Hokanson and W. I. Kern (Div. of United Aircraft Corp., Windsor Locks, Conn.). p.103-25 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

The results of this investigation indicate that electron beam welding offers a reproducible and reliable technique for the production of structural joints of adequate strength in tungsten and molybdenum. Welds of maximum strength and ductility were found to be dependent on limited fusion and recrystallized zones of minimum grain size in combination with smooth, continuous, non-undercut, crack-free weld beads. Minimum fusion and recrystallized zones were achieved through the use of maximum possible welding speed and minimal beam diameter. Highest quality weld beads were achieved using 60 cycle beam oscillation in the direction of welding. Mechanical property tests indicate that welds in both tungsten and Mo–0.5% Ti to themselves retained base metal strength at temperatures approaching the recrystallization temperatures. Relative tensile strengths decreased with decreasing temperature, reaching at room temperature, eighty percent of base metal strength for Mo–0.5% Ti and fifty percent of base metal strength for pure tungsten. The ductility of electron beam welds in both tungsten and Mo–0.5% Ti welded to themselves and Mo–0.5% Ti welded to tungsten was somewhat less than to the corresponding base metal ductility. Analysis of the bend testing technique indicated that ductility and associated ductile-to-brittle transition temperature data cannot be directly compared with comparable data for arc welds. In every case, the ductility data generated for electron beam welds were derived from a much more severe testing technique. (auth)

25764 THE ELECTRON BEAM POST HEATING OF ELECTRON BEAM WELDS. S. S. White and R. Bakish (Alloyd Electronics Corp., Cambridge, Mass.). p.126-38 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

The electron beam was shown to be a practical tool for the post heating of electron beam fusion and heat affected zones in steel and titanium in $\frac{1}{8}$ in. thickness. A technique for determining the simultaneous stress-strain characteristics of different metallurgical portions of a weldment was developed. The impact resistance of H-11 hot work die steel was shown to be related to both oxygen and nitrogen contents. Electron beam post heat treating of electron beam welds in A-286 causes stress relief and impact resistance increase with no loss in strength. Electron beam post heat treating of electron beam welds in type 301 stainless steel causes stress relief with essentially no change in other properties. Alloys such as titanium alloys that can be hardened by cold work and aging can have fusion and heat affected zones strengthened by electron beam post heat treating of electron beam welds in cold worked material. With all materials, moduli of elasticity can be selected or nearly matched in all metallurgical portions of a weldment through electron beam post heat treatment of an electron beam weld. (auth)

25765 RADIO-FREQUENCY INDUCTION BRAZING OF MOLYBDENUM IN VACUUM. J. F. Slepitis and F. H. Land (Curtiss-Wright Corp., Wright Aeronautical Div., Woodridge, N. J.). p.139-48 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

A brazing investigation was carried out on commercially pure sintered Mo sheet, using r-f induction heating in vacuum. Filler materials studied included Ti, Cr, V, and Nb, and "T" specimens were used. The results show Ti to be the best filler metal. (D.L.C.)

25766 SINTERING OF PLASMA ARC SPRAY FORMED TUNGSTEN. R. H. Singleton (General Motors Corp., Indianapolis). p.156-73 of "Transactions Vacuum Metallurgy Conference 1962." Boston, American Vacuum Society, 1963.

Large W pieces weighing more than 100 lb were fabricated successfully using the plasma arc spray-sinter process. The effects of the processing variables on the properties of the sintered products are described in detail. The effects of alloying additions are also considered. (D.L.C.)

25767 METHOD OF MAKING A NEUTRON-ABSORBING CALCIUM BORIDE BRICK. James W. Butler. U. S. Patent 3,092,590. June 4, 1963. Filed Feb. 1, 1960.

A method and a special mold are described for making a relatively inexpensive, durable shielding brick of CaB_6. The method comprises mixing 100 parts of CaB_6 powder with 5 to 10 parts water to form a thick dry mud, pressing the mud in the mold with a pressure of 1 to 2 tons/in.^{2} to form a brick, and baking the brick. In the baking step, the heat should be brought up slowly over 2 hr to a baking temperature of 600 to 900°C (750°C preferred), the temperature maintained for 2 to 6 hr, and the cooling carried out at the slowest rate possible. (D.L.C.)

Properties and Structure

Refer also to abstracts 26094, 26168, 26173, 26174, 26175, 26176, 26452, 26453, 26455, 26456, 26457, 26772, 26773, 26775, 26779, and 26789.

25768 (AD-403526) X-RAY DIFFRACTION STUDY OF DEFORMATION BY FILING IN BCC REFRACTORY METALS. Technical Report No. 4. E. N. Aqua and C. N. J. Wagner (Yale Univ., New Haven. Hammond Metallurgical Lab.). Mar. 1963. Contract NONR 609(43). 52p.

The bcc refractory metals, Nb, Ta, V, Cr, and W were cold worked by filing at room temperature. The broadening of the powder pattern peaks was studied by Fourier analyses of the line shapes. The effective particle sizes, $D_e(hk\ell)$, and root mean squared (rms) strains were measured in different crystallographic directions. Anisotropic values of particle sizes observed in Ta and Nb were an indication of faulting in the metals. The degree of anisotropy of particle sizes was much smaller in V; W and Cr showed isotropic particle sizes. The ratio of rms strains may be calculated from the directional variation of Young's modulus. The absolute magnitude of rms strains was also computed for isotropic bcc metals without faulting. The amount of faulting was observed to increase with the degree of elastic anisotropy of the bcc metals of the group Vb. Metals of group VIb showed no x-ray diffraction evidence of faulting. (auth)

25769 (AMRA-CR-63-02/1(F)) AN INVESTIGATION OF TRANSFORMATION CHARACTERISTICS OF THREE URANIUM BASE ALLOYS. Final Report. P. E. Repas, R. H. Goodenow, and R. F. Hehemann (Case Inst. of Tech., Cleveland). Jan. 1963. Contract DA-33-019-ORD-3630. 82p.

TTT (transformation temperature time) diagrams are presented and transformation kinetics is described for five alloys: U–10% Mo, U–8% Mo, U–8% Mo–½% Ti, U–8% Mo–1% Ti, and U–2% Mo–2% Nb–2% Zr–½% Ti. Metallographic, dilatometric, hardness, and x-ray techniques were utilized in establishing the TTT diagrams. Sensitivity and limitations of each technique are discussed. Metallographic techniques were perfected for the U-base alloys for nearly all conditions of heat treatment. Certain low temperature transformation structures and the identification of nonmetallic inclusions were not completely resolved. Metallographic structures of the specimens were interpreted where possible in terms of the established TTT diagrams. (P.C.H.)

25770 (ARF-B6012-1) STUDIES OF THE BRITTLE BEHAVIOR OF CERAMIC MATERIALS. Quarterly Report No. 1. N. M. Parikh and W. Rostoker, eds. (Illinois Inst. of Tech., Chicago. Armour Research Foundation). May 31, 1963. Contract AF33(657)-10697. 110p.

Investigations on the relation between failure strengths and strain rates for Al indicate no appreciable strain rate effect at room temperature, but data at elevated temperatures indicate that a significant effect exists. The results of the effects of nonuniform stress fields upon the fracture characteristics of Al_2O_3 show that two different specimens have almost the same mean failure stress, although the stress gradients are widely different, having a ratio of about 4 to 1. This suggests that there is no stress gradient effect per se on failure stress and that the material is governed by volumetric flaw distribution. A continuum theory was developed for calculation of force constants for charged dislocations in MgO crystals. Similarity between activation energies of the internal and steady state creep in Al_2O_3 suggests that the latter is grain boundary controlled at low stress (3600 psi) and temperature (below 1300°C) levels. This effect, combined with an apparent insensitivity of the activation energies of the processes to atmosphere, suggests grain boundary control through impurity domination. Tests on surface and fracture energy of Al_2O_3, MgO, and glass show that the crack branching criteria yield approximately the correct reversible surface energy for values of K close to unity. Fracture mechanics for MgO are also discussed. MgO doped with Al, Fe, or Cr increased in microhardness with increasing amounts of impurity. Modulus of rupture for the same systems was found to decrease or remain essentially constant with increasing impurity content. On the other hand, MgO doped with Zr, Sr, or Ti decreased in microhardness with increases in the added impurity. The tensile strength of polycrystalline hot-pressed MgO was also measured. The tensile strength seemed to be insensitive to heat treatment or surface condition. It was found that porosity does not affect the strength of Al_2O_3 as much as grain size, intergranular pore size, and intergranular pore spacing. (P.C.H.)

25771 (ASD-TDR-62-667) DEVELOPMENT OF IMPROVED VANADIUM-BASE ALLOYS FOR ELEVATED-TEMPERATURE USE. V. C. Petersen and H. B. Bomberger (Crucible Steel Co. of America, Pittsburgh). May 31, 1962. Contract AF 33(616)-7288. 66p. (AD-290341)

Vanadium-base alloys with improved mechanical properties at elevated temperatures were developed. The screening criteria included density-corrected hot hardness at 1800°F as well as forgeability performance at 2300°F. The hot-hardness apparatus designed for the work permits loading up to 14 specimens at one time and testing up to 1800°F in vacuum. The validity of hot hardness as a hot strength parameter was established by a correlation with hot-strength data. In the exploratory work, 174 binary and multi-addition alloys were levitation-melted in 10-g charges. On the basis of the studies of the microstructures, forgeability, and hot hardness of the alloys, 14 compositions were selected as most promising and were scaled up to larger melts. Screening data (rollability, hot hardness, and hot tensile properties) on the larger melts showed three compositions to be superior: V–20Nb–5Ti, V–25Mo–2.5 Hf, and V–35Cr–1Zr. These alloys demonstrated better forgeability and superior 2000°F tensile strength than the well-known V–20Nb–5Ti alloy. Iron and Sn were also found to be promising alloying elements. (auth)

25772 (ASD-TDR-63-360) INVESTIGATION OF THE RELATIONSHIP OF TWINNING TO BRITTLE FRACTURE OF REFRACTORY METALS. C. N. Reid, A. Gilbert, and G. T. Hahn (Battelle Memorial Inst., Columbus, Ohio). Mar. 1963. Contract AF33(657)-7376. 48p.

Evidence was found for brittle fracture induced by mechanical twinning in single crystals and polycrystalline Mo–C with grain size larger than 0.40 mm. However,

there is no evidence for such failures in Mo–C of grain size smaller than 0.25 mm, or in high-purity Nb. The effect of recrystallization texture on twinning is demonstrated, and the orientation dependence of twinning in Nb crystals is reported; a most unusual plastic instability is described in crystals of one orientation. It is shown that twinning in Mo–35Re occurs in bursts, which form in less than 2 μsec. The contribution of twinning to the deformation of Mo–35Re decreases with increasing strain. (P.C.H.)

25773 (DRI-2099) A STUDY OF THE SYNTHESIS AND PROPERTIES OF TRANSITION METAL HYDRYLS. Third Quarterly Progress Report, January 1, 1963 through March 31, 1963. C. B. Magee, R. W. Sullivan, R. J. Bayuzick, and C. Cheng (Denver. Univ. Denver Research Inst.). Apr. 17, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1185. 27p. (EURAEC-666)

Analyses of data obtained in measurements of hydrogen pressure as a function of condensed phase composition at a number of fixed temperatures, resulted in the establishment of a tentative ternary phase diagram for the Li–Rh–H system. The diagram, which contains the compounds LiH, LiRh, $Rh_2(LiH)_8$, and $Rh(LiH)_4H$, is consistent with most results so far obtained but not in accord with some experimental data. It was found that Armco iron crucibles, because of reactions of Li with inclusions in the Armco iron, are not suitable for equilibrium pressure measurements. Preliminary experiments in which LiH was reacted with Ir and Co in a 4 to 1 molar ratio resulted in products that have x-ray diffraction patterns similar to those attributed to the Li Rh hydryls. It was tentatively concluded that Ir and Co form hydryls. Studies of the Li–Rh and Li–Ir binary systems confirmed the existence of a unique phase in the Li–Rh system, and resulted in the discovery of a unique phase in the Li–Ir system. The x-ray diffraction patterns of the two phases are almost identical; both are simple hexagonal, the lattice parameters of the Li–Rh phase are $a_0 = 2.66$ Å and $c_0 = 4.35$Å while those of the Li–Ir phase are $a_0 = 2.64$Å and $c_0 = 4.39$Å. The evidence obtained so far suggests that the Li–Rh phase is of the stoichiometry LiRh. (P.C.H.)

25774 (NAA-SR-Memo-8336) COEFFICIENT OF FRICTION BETWEEN ZIRCONIUM ALLOY II AND GRAPHITE. M. Dudley (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 21, 1963. Contract [AT-11-1-GEN-8]. 8p.

Overall-average values of the coefficient of friction between Zr alloy and graphite measured up to 1200°F range from 0.354 at 600°F to 0.305 at 1200°F. The averaged friction data are plotted. Also included are the minimum, maximum, and average values obtained with and without vibration. (P.C.H.)

25775 (NMI-7246) POWER REACTOR PROGRAM. Progress Report to Savannah River Operations Office, United States Atomic Energy Commission for the Period December 1, 1961–December 31, 1961. S. Isserow, R. W. Anderson, W. L. Larson, and A. R. Gilman (Nuclear Metals, Inc., Concord, Mass.). Feb. 7, 1962. Contract AT(30-1)-2784. 16p.

Work continued on the development of procedures for end capping HWCTR metal tubes by brazing. A chemical milling process was established capable of producing recesses with smooth surfaces at a practical rate. The formation of voids in the braze alloy was reduced by increasing the time at brazing temperature and by slowly cooling the braze alloy. Procedures were established for obtaining reproducible hot hardness values for uranium by proper sample preparation and uniform method of measurement. The hardness of uranium was determined from room temperature to 600°C. No difference in hardness was observed between ingot and dingot stocks. The hardness of U–0.3 wt % Al–0.5 wt % Si alloy as solution treated and as aged was determined from room temperature to 500°C; the values were higher by a factor of two than for uranium. A preliminary estimate of the solubility of Si in U–0.3 wt % Al at 950°C was 0.18 to 0.25 wt %. A comparison was made of cladding thicknesses determined for inner and outer HWCTR tubes by autoradiography and eddy current measurements. For the outside claddings an eddy current value can be converted to a corresponding autoradiography value by applying a correction of about one mil. For the inside cladding of outer tubes, no correction is necessary. (auth)

25776 (NP-12812) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Progress Report No. 9, January–March 1963. (Lockheed Georgia Co., Marietta, Ga.). Contract NASw-114. 88p. (ER-6219)

Progress made in the development of the Plum Brook Reactor is reported. Preparation for in-pile testing continued with modification of the test loops and the test loop transfer system carriages. Procedures were written outlining the method of operating test equipment which will be used in the test program. Remote tool fabrication continued. Chemical analyses of the reactor primary water indicated the presence of tungsten contamination and an investigation was undertaken to determine the source. Tensile properties of aluminum alloys, stainless steels, nickel alloys, and titanium alloys were evaluated at 30 and 540°R. (N.W.R.)

25777 (NP-12874) A STUDY OF FUNDAMENTAL MECHANICAL PROPERTIES OF CERAMIC SINGLE CRYSTALS. Bi-Monthly Progress Report No. 2, March 15–May 14, 1963. P. T. B. Schaffer and H. D. Batha (Carborundum Co. Research and Development Div., Niagara Falls, N. Y.). May 22, 1963. Contract N600(19)-59749. 7p.

Data on strength and elastic properties of boron-doped silicon carbide crystals were obtained on thin (10 to 70 μ) crystals, and are tabulated. Analyses are being made to determine the specific effect of impurities on strength. (auth)

25778 (NP-12878) [ELASTIC PROPERTIES OF CARBONS AND GRAPHITES]. Progress Report No. 17, November 1, 1962–May 1, 1963. N. Juul, S. Sato, and H. E. Strauss (New York. State Univ., Buffalo). Contract AF33(616)-7791. 24p.

The results of measurements on Young's modulus in dependence on temperature from baked to graphitized state for a hard filler-hard binder (HF-HB) carbon are reported. Also, two special types of carbon were investigated: the glassy carbon and a low density carbon. The study on the temperature dependence of the Young's modulus for the carbons gave some indication as to the nature of starting materials. In measurements on the thermal conductivity and electric resistivity on a soft filler-hard binder carbon, curves for 2100 and 2400°C heat treatment were obtained. An improved furnace for the steady sinusoidal heat flow method of measuring the diffusivity was built and tested in operation. (P.C.H.)

25779 (NP-12891) RESEARCH PROGRAM RELATED TO VAPOR THERMIONIC CONVERTERS FOR NUCLEAR APPLICATION. Quarterly Progress Report, Decem-

ber 27–March 27, 1963. A. O. Jensen (Electro-Optical Systems, Inc., Pasadena, Calif.). Apr. 24, 1963. Contract NAS-3-2529. 54p. (EOS-3410-Q-2)

The effects of long time at temperature on the surface crystal structure of polycrystalline molybdenum substrates and how these changes in surface crystal structure relate to the performance of cesiated molybdenum emitters for use in cesium vapor thermionic converters for nuclear applications are investigated. Information is presented on pole figure determination, grain growth, grain size, and crystal orientation. Testing of an electron microscope, thermionic converter environment, and tantalum container is discussed. (N.W.R.)

25780 (ORNL-TM-535) STRESS-RUPTURE PROPERTIES OF TYPE 304 STAINLESS STEEL TUBING. J. T. Venard (Oak Ridge National Lab., Tenn.). June 7, 1963. Contract W-7405-eng-26. 27p.

A single heat of type 304 stainless steel tubing was burst tested in air to determine its stress-rupture properties at temperatures ranging from 1100 to 2200°F and times up to 4000 hr. The data are presented in graphic form showing log stress vs log time-to-rupture and log strain vs log time-to-rupture. The effect of specimen size on stress-rupture behavior was examined as was the effect of testing in an atmosphere of 90 vol % He, 8 vol % N_2, 2 vol % O_2. Correlation of the data up to 2000°F using the Dorn Parameter is shown to be valid. The data at 2200°F do not agree with the correlation. It is also shown that there is no size effect of 6.0-in. vs 2.5-in.-long specimens at temperatures of 1600°F and below. No difference was seen between stress-rupture tests run in air and those in 90 vol % He, 8 vol % N_2, 2 vol % O_2. Strain-at-rupture results indicate decreasing strains with increasing time. The strains observed at 1200 to 1600°F were similar and somewhat smaller strains were observed at 1100 and 1800°F. (auth)

25781 (TID-18738) HIGH TEMPERATURE OXIDATION AND NITRIDATION OF NIOBIUM IN ULTRAHIGH VACUUM. Quarterly Report No. III, December 1, 1962 to April 1, 1963. (Stanford Research Inst., Menlo Park, Calif.). Apr. 26, 1963. Contract AT(04-3)-115. 18p.

An experimental unit was tested extensively, and preliminary data were obtained for sorption of N and O by Nb. It appears that systematic data for the Nb–N interactions can now be collected, at least for pressures above 10^{-8} torr. Significant data for O sorption were also obtained for pressures of 10^{-7} torr or higher. (P.C.H.)

25782 (TID-18791) METALLURGICAL STUDIES OF ZIRCONIUM AND THORIUM AND OF THE ALLOYING BEHAVIOR OF RARE EARTH-TRANSITION METAL SYSTEMS. Progress Report. (Rensselaer Polytechnic Inst., Troy, N. Y.). June 1963. Contract AT(30-1)-2159. 10p.

The following investigations are discussed: the effects of rare earth additions on the allotropic transformation temperature of thorium and zirconium, determinations of the effects of rare earth additions on the surface tension of liquid thorium alloys, determinations of the solubility limits of rare earths in thorium, and theoretical analyses and calorimetric measurements of the solubility limits and partial molar heats of mixing of zirconium–rare earth systems. (N.W.R.)

25783 (UCRL-7210) ORDERING IN NiMn. James R. Wolfe (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 25, 1963. Contract W-7405-eng-48. 34p.

The ordering reaction in NiMn was followed by x-ray diffraction, metallographic, and resistivity techniques and is shown to be a heterogeneous phase transformation. The kinetics of the phase transformation were studied by following the change in resistivity of the alloy during isothermal ordering. The temperature dependence of the transformation can be described by the Arrhenius relation, which leads to an "apparent" activation energy of 50.7 kcal for the reaction. The time dependence of isothermal ordering is not describable in terms of a single reaction rate equation. (auth)

25784 (UCRL-7289) FUTURE TRENDS IN BERYLLIUM METALLURGY RESEARCH. Rointan F. Bunshah (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 29, 1963. Contract W-7405-eng-48. 24p.

A review of the nature and limitations of commercial Be is presented. The effects of purification strongly suggest that impurities in commercial Be cause brittleness and limit its potential applications. Future research trends are discussed. It is felt that production of super-purity Be (99.995% pure) should be undertaken to see whether the brittleness problems can be solved, followed by a study of the pure alloys. (P.C.H.)

25785 (UCRL-10714) ORIGIN AND MULTIPLICATION OF DISLOCATIONS. A Review Presented at the AIME Western Metals Congress, March 1963, Los Angeles. G. Thomas (California. Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 39p.

Dislocations appear to be formed easily in metals even when the most careful preparation techniques are employed. The origin of dislocations appears to be most satisfactorily explained by heterogeneous nucleation and multiplication due to stresses arising during solidification, particularly at grain boundaries and impurities. Multiplication of dislocations during plastic strain readily occurs by a number of processes essentially similar to the Frank-Read mechanism as soon as a dislocation starts to move. In polycrystals, grain boundaries appear to be the most common sources of dislocations. The differences in behavior between metals of different crystal structures, ionic and covalent crystals is not well formulated at the present time. More experimental work on the formation and growth of slip bands, e.g., by correlation of surface slip markings with the direct observations of dislocation arrangements in the bands, is essential before a complete understanding is to be obtained. (auth)

25786 (UCRL-13075) FEASIBILITY STUDY ON THE DIFFUSION BONDING OF URANIUM. Robert C. Bertossa (Pyromet Co., San Carlos, Calif.). Oct. 15, 1962. For Univ. of California Lawrence Radiation Lab., Livermore. Contact [W-7405-eng-48]. 14p.

Studies were made on the feasibility of effecting diffusion bonding in U, using pure Au as a catalyst, and by solid state diffusion without the use of a catalyst. It was found that the Au appeared to have promising characteristics for catalyzing the diffusion bonding reaction in joining uranium to itself. Phase diagrams are given U–Au, U–Cr, U–Co, U–Cu, U–Fe, U–Mn, and U–Ni alloys. (P.C.H.)

25787 FACTORS AFFECTING LEAD ZIRCONATE-LEAD TITANATE CERAMICS. Peter D. Levett (Minneapolis-Honeywell Regulator Co., Minneapolis). Am. Ceram. Soc. Bull., 42: 348-52(June 7, 1963).

Findings indicated that in order to obtain reproducible lead zirconate–lead titanate ceramics, either by hot pressing or by atmosphere firing, extremely close control is needed at all stages of processing, from initial raw material selection through to final firing. Small compositional changes can produce marked changes in final physical and electrical properties including density, dielectric constant,

planar coupling coefficient, and hysteresis loop characteristics. It is important to know the purity level and particle size of all raw materials to prevent variations occurring in final properties. Investigations indicated that considerably greater uniformity of properties together with improved electrical properties could be obtained from ceramics prepared by hot-pressing techniques. (auth)

25788 STUDY OF THE ISOTHERMAL TRANSFORMATION KINETICS OF THE RETAINED β PHASE IN URANIUM–CHROMIUM ALLOYS BY TEMPERING WITH WATER FROM THE β RANGE. Michel Degois and René Faivre (Faculté des Sciences; ENSMIN; and CEA, Nancy, France). Compt. Rend., 256: 3685-8 (Apr. 22, 1963). (In French)

Low-inertia thermal dilatometry, described previously (Compt. rend. 255, 3185(1962)), was used to study the isothermal transformation kinetics of the retained γ phase in U–Cr alloys. In isothermal condition, the transformation law is $1 - x = \exp[-(kt)^n]$, where x is the degree of transformation, k a coefficient, and n an exponent independent of time. The activation energy is 14,000 cal/mole for the bainitic transformation of alloys containing less than 1 at. % Cr and 35,000 cal/mole for the transformation by germination and growth of alloys containing more than 1 at. % Cr. (tr-auth)

25789 THE ELECTRON MICROSCOPY OF THIN METAL FOILS. J. Silcox (Cornell Univ., Ithaca, N. Y.). Contemp. Phys., 4: 256-77(Apr. 1963).

The nature of the defects in crystal structures and the way in which they can be studied by electron microscopy of thin metal foils are discussed in detail. Examples of phenomena observed in metals with the electron microscope are briefly presented. These include the dislocation structures introduced by work hardening, fatigue, quenching and irradiation; examples of microstructures found in alloys; and magnetic domain walls. (auth)

25790 A STUDY OF THE NIOBIUM–BERYLLIUM SYSTEM. P. M. Arzhanyi, R. M. Volkova, and D. A. Prokoshkin (Baikov Inst. of Metallurgy, USSR). Dokl. Akad. Nauk SSSR, 150: 96-8(Mar. 1, 1963). (In Russian)

Beryllium metal reacted with a surface of niobium metal at a saturation temperature of 900 to 1300°C to form the following intermetallic compounds in definite layers: $NbBe_{12}$, $NbBe_8$, $NbBe_5$, and $NbBe_2$. The layers were identified by microstructural and x-ray analysis, by chemical analysis, and by the change in microhardness. The $NbBe_5$ compound has a microhardness of 1580 kg/mm^2. The diffusion coefficients for the formation of the $NbBe_{12}$ and $NbBe_8$ layers can be expressed by the following equations: $D(NbBe_{12}) = 7.66 \times 10^{-4} \exp(-32{,}000/RT)$, and $D(NbBe_8) = 5.7 \times 10^{-9} \exp(-14{,}740/RT)$. In order to elucidate the phase diagram of the Nb–Be system, alloys of $NbBe_{12}$, $NbBe_8$, and $NbBe_2$ were prepared by fusion in a vacuum, arc furnace. It was found that the intermetallic compounds $NbBe_{12}$, $NbBe_8$, and $NbBe_2$ melt at temperatures of 1645, 1750, and 2080°C respectively. The $NbBe_5$ compound was formed by a peritectic reaction at 1820°C. Be and $NbBe_{12}$ formed a eutectic at 1260°C with a microhardness of ~260 kg/mm^2. A eutectic between $NbBe_8$ and $NbBe_{12}$ with a hardness of 950 kg/mm formed at 1490°C. The eutectic between $NbBe_5$ and $NbBe_8$ melted at a temperature of 1675°C. A eutectic with a microhardness of ~1079 kg/mm^2 formed at 2000°C between $NbBe_2$, and a solid solution of beryllium in niobium. The heats of formation were found to be 29.8 ± 9.6 for $NbBe_{12}$, 20.5 ± 3.2 for $NbBe_8$, 46.4 ± 3.8 for $NbBe_5$, and 14.6 ± 1.9 kcal/mol for $NbBe_2$. A phase diagram of the Nb–Be system is presented. (TTT)

25791 SOME HIGH PRESSURE STUDIES ON YTTERBIUM. H. Tracy Hall and Leo Merrill (Brigham Young Univ., Provo, Utah). Inorg. Chem., 2: 618-24(June 1963).

Pressure, temperature, volume, resistance, and x-ray diffraction measurements made it possible to establish a partial P-T phase diagram for metallic ytterbium. An electronic transition, previously indicated as occurring at 60 kb., 25°, is shown to occur at 39.5 kb., 25°. This transition pressure is lowered by increasing temperature, $\Delta P/\Delta T$ being −19.1 bars/deg., and is accompanied by a change in volume of −0.65 cm^3/mole simultaneously with a change in crystal structure from FCC to BCC. This is the first time a pressure-induced transition from a close-packed to a non-close-packed structure has been observed. Heat absorption at the transition is 89 cal/mole. A number of second-order transitions were discovered. Of particular interest are transitions in bond type from P-T regions in which directional bonds predominate to P-T regions in which metallic bonding predominates. (auth)

25792 PHASE RATIO IN Y_2O_3–ZrO_2 SYSTEM. II. SOLID SOLUTIONS. Fu-k'ang Fan, A. K. Kuznetsov, and E. K. Keler (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, No. 4, 601-10(Apr. 1963). (In Russian)

A new constitution diagram for Y_2O_3–ZrO_2 solid solutions (at 500 to 2500°C) was analyzed and compared to the diagram suggested by P. Duwez et al. (Electrochem. Soc., 98: No. 9, 356(1951)). The necessary minimum amount of Y_2O_3 for Zr stabilization depends on the annealing temperature. (R.V.J.)

25793 REASONS FOR THE CHOICE OF THE Mg–Zr ALLOY FOR THE CANNING OF FUEL ELEMENTS. R. Caillat, J. Hérenguel, M. Salesse, and J. Stohr (CEA, Saclay, France). J. Nucl. Mater., 8: 1-2(Jan.-Feb. 1963). (In French)

The reasons which determined the adoption of Mg–Zr alloy for canning the fuel elements for the carbon dioxide-cooled French reactors are presented. This alloy combines a good corrosion resistance with acceptable mechanical properties, even after long periods at 400 or 450°C. (auth)

25794 UTILIZATION OF THE Mg–Zr ALLOY FOR CANNING MATERIAL. J. L. Bernard and B. Boudouresques (CEN, Saclay, France). J. Nucl. Mater., 8: 3-11(Jan.-Feb. 1963). (In French)

The properties of the Mg–0.6 wt. % Zr alloy, considered from the point of view of its use as canning material for fuel elements in CO_2-cooled graphite-moderated reactors are presented. After the various methods of fabrication (wire-drawing, machining, etc.) and of canning are described, it is shown how the practical requirements can be satisfied by the principal properties of this alloy, viz. mechanical strength, ductility, metallurgical stability toward heat treatment, weldability, and good stability under irradiation. (auth)

25795 ON A NEW NUCLEAR MATERIAL: SINTERED MAGNESIUM OXIDE. M. Salesse, R. Caillat, and J. Hérenguel (CEA, Saclay, France). J. Nucl. Mater., 8: 39-40 (Jan.-Feb. 1963). (In French)

The principal characteristics of a nuclear material, sintered oxidized magnesium, which combines the low neutron capture cross section of magnesium with high-temperature mechanical properties similar to those of SAP are described. (auth)

25796 GRAIN-BOUNDARY DENUDED ZONES IN A MAGNESIUM-½ wt. % ZIRCONIUM ALLOY. R. L. Squires (United Power Co. Ltd., Erith, Kent, Eng.), R. T. Weiner,

and M. Phillips. J. Nucl. Mater., 8: 77-80(Jan.-Feb. 1963). (In English)

Metallographic studies were made of Mg–½ wt. % Zr alloy. It was found that very heavy precipitation took place during creep testing and that denuded zones developed at grain boundaries. The precipitate was identified as ZrH_2. Grain growth was isotropic and ceased after about 200 hr, so that during creep tests of more than 1000 hr duration the grain morphology was stable for most of the time. It was concluded that a possible explanation of the denuded zones is that during deformation a form of directional diffusion was occurring that had some similarities with that involved in Nabarro-Herring creep. It was therefore suggested that the zirconium hydride precipitate acts as a marker, and that magnesium atoms diffuse into the grain boundaries that lie at right angles to the applied stress. (M.C.G.)

25797 CONTRIBUTION ON THE INVESTIGATION OF THE ESCAPE OF FISSION GAS FROM IRRADIATED SINTERED URANIUM OXIDE. J. L. Berry, R. Darras, H. Chevilliard, and T. Gerevini (CEN, Saclay, France). J. Nucl. Mater., 8: 102-15(Jan.-Feb. 1963). (In French)

After a description of the apparatus and experimental method used, preliminary results are reported of a study on the escape of fission gases from sintered uranium oxide, weakly irradiated. These results revealed in particular the considerable influence of the atmosphere in which the sintered compacts were stored and treated and of their surface condition and specific surface area (this last characteristic turned out to be more significant than the density). "Effective" diffusion coefficients D′ were estimated at 1400°C for various grades of UO_2, including "monocrystalline" pieces for which $D'_{mean} = 6.9 \times 10^{-14}$/sec. Where the specific surface area of the sintered compacts could be measured, the true diffusion coefficient D was deduced from the measured "effective" coefficient. (auth)

25798 PLASTIC DEFORMATION AND RUPTURE OF MONOCRYSTALLINE URANIUM BY TENSILE STRESS AT −196°C. A. Lemogne and P. Lacombe (Ecole des Mines, Paris). J. Nucl. Mater., 8: 116-25(Jan.-Feb. 1963). (In French)

The plastic behavior of uranium monocrystals, made by the phase-transformation method, was studied by tensile testing at −196°C. The principal deformation modes found at room temperature are also active at −196°C, with the exception of cross slips and deformation bands. The most notable characteristics are the very small plastic elongation before fracture, and the liability of uranium to fail by "parting" on a twin composition plane. (auth)

25799 RECRYSTALLIZATION TEMPERATURE OF ZONE-MELTED URANIUM. G. Clottes (CEN, Saclay, France). J. Nucl. Mater., 8: 143-7(Jan.-Feb. 1963). (In French)

Measurements of the ratio of the resistance of zone-melted U samples of 293°K to that at 78°K, of the polycrystalline microhardness of the samples, of the x-ray scattering by the samples, and of the surface details of the samples under polarized light are carried out. These measurements are used to calculate the recrystallization temperature of the zone-melted U (namely, 270°C), and to show that a pronounced grain growth takes place during the zone melting of electrolytic-purity U. (T.F.H.)

25800 TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS OF THORIA SPECIMENS OF VARYING POROSITY. S. Spinner, L. Stone, and F. P. Knudsen. J. Res. Natl. Bur. Std., 67C: 93-100 (Apr.-June 1963).

The temperature dependence of Young's and the shear modulus of 18 thoria specimens of porosities ranging from 3.7 to 39.4 percent was measured by the dynamic resonance method. The temperature range of the measurements was from 25 to 1300°C. The moduli decreased with increasing temperature in general accordance with the pattern observed for other polycrystalline materials. The relative decrease in modulus with temperature for all the materials was essentially independent of porosity up to about 800°C. Above this temperature the relative decrease in modulus for the high porosity specimens tended to be more rapid than for the low porosity specimens. Also, Poisson's ratio for any particular specimen remained constant over the entire temperature range of measurement. (auth)

25801 DETERMINATION OF THE PORE STRUCTURE OF GRAPHITE. L. Kuechler and E. G. Schlosser (Farbwerken Hoechst A.G., Frankfurt am Main). Kerntechnik, 5: 145-52(Apr. 1963). (In German)

The pore structure of graphite responsible for the diffusion of stable or radioactive substances is determined by calculating the fractions of inaccessible pores, "through" pores, and "blind" pores. For this purpose, the results of several experimental methods are combined, especially pore-size distribution, permeability constant, and bulk density. (auth)

25802 QUANTITATIVE AND STRUCTURAL ELECTRON MICROPROBE STUDIES OF SINTERED ALUMINUM. R. Theisen (Euratom, Ispra, Italy). Mem. Sci. Rev. Met., 60: 189-94(Mar. 1963). (In French)

The distribution of the constituents of different dispersion-strengthened sintered aluminum alloys was studied by means of a Castaing microprobe and a complementary automatic scanning device. The chemical composition of the iron-rich inclusions was determined by static local microanalysis. A method for automatic and selective determination of concentration and size of inclusions was developed. The influence of impurities on mechanical and corrosion resistance and the conditions of diffusion bonding of SAP nuclear fuel cannings was evaluated. (auth)

25803 HALL COEFFICIENT OF ALPHA PLUTONIUM. Merwyn B. Brodsky (Argonne National Lab., Ill.). Phys. Rev., 131: 137-40(July 1, 1963).

The Hall coefficient of alpha plutonium was found to be $+2.8 \times 10^{-13}$ at 388°K and -6.5×10^{-13} (v-cm)/(A-G) at 78°K. The variation between these extreme temperatures was found to change gradually with temperature and the value changes sign at 190°K. No field dependence of Hall voltage was found, nor did the application of 11,500 G affect the resistivity maximum at 100°K. It is concluded that the resistivity maximum is not due to magnetic ordering. An observation by Loasby and Taylor that the Hall coefficient changes with time at 77°K was not confirmed here. The results were used to calculate the numbers of holes and electrons as a function of temperature on the two-band model. The calculations show that a narrow 5f-6d band and broad 7s conduction band is more likely than a narrow 5f and broad 6d band. (auth)

25804 ANISOTROPIC DIFFUSION OF CADMIUM AND GOLD TRACERS IN ZINC SINGLE CRYSTALS. P. B. Ghate (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 131: 174-8(July 1, 1963).

The anisotropic diffusion coefficients of the radioactive tracers cadmium-115m and gold-198 in single crystals of

high-purity zinc, in directions parallel and perpendicular to the hexagonal axis, were measured by the standard sectioning technique. Cadmium diffused at a rate faster than that of self-diffusion and with $D_{\perp} > D_{||}$. Gold diffused at a rate slower than that of self-diffusion and with $D_{||} > D_{\perp}$. The results of the measurements are presented. On the basis of the vacancy mechanism one can interpret the fast diffusion of cadmium in terms of an appreciable binding between the vacancy and the diffusing ion; conversely the slow diffusion of gold in terms of a repulsion between the vacancy and the diffusing ion. (auth)

25805 MOSSBAUER STUDY OF HYPERFINE FIELDS AND ISOMER SHIFTS IN THE Fe–Rh ALLOYS. G. Shirane (Westinghouse Research Labs., Pittsburgh), C. W. Chen, P. A. Flinn, and R. Nathans. Phys. Rev., 131: 183-90 (July 1, 1963). (BNL-6802)

Hyperfine fields and isomer shifts of Fe^{57} in the Fe-Rh system were investigated by the Mössbauer technique in the composition range between 0 and 52 at. % Rh. When the Rh concentration exceeds 20%, chemical ordering of CsCl type develops and two distinct hyperfine fields are observed, corresponding to Fe on Fe sites and Fe on Rh sites. For example, $H_i(I) = 277$ kOe and $H_i(II) = 384$ kOe in an alloy containing 48% Rh. Neutron diffraction study of this alloy gave $\mu_{FeI} = 3.2\ \mu_B$, but no direct measurement is available for μ_{FeII}. It is suggested that FeII, which is surrounded by 8 Fe nearest neighbors, may have a smaller magnetic moment than FeI despite its higher hyperfine field. The alloy with 50% Rh transforms, on cooling, from ferromagnetic to antiferromagnetic at 65°C. At this phase transition the hyperfine field shows a discontinuous decrease of 14 kOe. (auth)

25806 ATTENUATION OF ULTRASONIC SHEAR WAVES IN SUPERCONDUCTING ALUMINIUM. R. David, H. R. Van der Laan, and N. J. Poulis (Kamerlingh Onnes Laboratorium, Leiden). Physica, 29: 357-69(Apr. 1963). (In English)

The attenuation of ultrasonic shear waves with frequencies between 2.5 and 25 Mc is measured in two single crystals of superconducting aluminum for different polarization directions. At the transition temperature, a steep but continuous drop of the attenuation is observed. The remaining part of the attenuation fits into the BCS theory. No anisotropy is found for the zero-temperature energy gap, but the shapes of the attenuation vs temperature curves are strongly orientation-dependent. Some measurements are also performed at small magnetic fields. (auth)

25807 THEORY OF THE RESISTANCE OF THE RARE EARTH METALS. R. J. Elliott and F. A. Wedgwood (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 81: 846-55(May 1, 1963).

The electrical resistance of the heavy rare earth metals shows strong anomalies at the temperatures where the magnetic order changes. These are most marked in measurements made along the hexagonal axis. A simple theory of the effect is given on the basis of two mechanisms. The spiral spin structures found in these materials cause an exchange field at the conduction electrons with a lower symmetry than that of the lattice. This introduces new boundaries in the Brillouin zone and distorts the Fermi surface. This distortion and the scattering of the conduction electrons by the spin disorder in these materials is calculated. The order of magnitude of the effect agrees with that calculated for a simple spherical Fermi surface. Agreement between experiment and theory is improved by assuming that the Fermi surface lies inside a boundary of the original zone and is cut by a new superlattice boundary near its extremity. Further improvement is made by including the variation of the spiral pitch with temperature. (auth)

25808 FREQUENCY DISTRIBUTION OF THE LATTICE VIBRATIONS IN SODIUM. A. E. Dixon, A. B. D. Woods, and B. N. Brockhouse (Atomic Energy of Canada Ltd., Chalk River, Ont.). Proc. Phys. Soc. (London), 81: 973-4(May 1, 1963).

The frequency distribution of lattice vibrations in Na were calculated on the Born-von Kármán theory using force constants obtained from neutron inelastic scattering experiments and considering general interactions out to fifth neighbors. Several critical and saddle points of the distribution function were identified, and the specific heat and equivalent Debye temperature of Na were calculated from the results. (D.C.W.)

25809 THERMOELECTRIC EMISSION OF W–Hf AND W–Ti ALLOYS AND EFFECTS OF OXYGEN PRESSURE ON IT. B. Ch. Dyubua, A. I. Peskarev, B. N. Popov, and M. A. Tylkina. Radiotekhn. i Elektron., 7: 1566-73(Sept. 1962). (In Russian)

Constitution diagrams for W–Hf and W–Ti alloys were constructed, and thermoelectric emission properties were measured. It was found that the yields for solid solutions are smaller than for pure metals. Effects of oxygen on the emission properties were also examined. (tr-auth)

25810 EMISSION PROPERTIES OF THORIUM AND YTTRIUM OXIDES ON RHENIUM AND NIOBIUM BASE CATHODES. M. V. Koganovich and R. A. Makarova. Radiotekhn. i Elektron., 7: 1579-84(Sept. 1962). (In Russian)

Properties of ThO_2 and Y_2O_3 in electron-tube applications are discussed. Thermal activation, thermal and secondary emission properties, and poisoning effects in coatings on Nb and Re base cathodes are investigated. The obtained data are compared to the data on Ta and Mo base cathodes. (tr-auth)

25811 THERMIONIC PROPERTIES OF GROUP IV AND V CARBIDES. B. V. Bondarenko and S. V. Ermakov. Radiotekhn. i Elektron., 7: 2099-2101(Dec. 1962). (In Russian)

Thermionic emissions from HfC, NbC, TaC, TiC, VC, and ZrC were measured at 1400 to 2000°K. The data show that ZrC and NbC are suitable as thermionic cathode material. The emission current density of NbC at 2000°C was 3.6 amp/cm^2. (R.V.J.)

25812 THERMIONIC EMISSION OF METAL SILICIDES OF TRANSITION GROUPS ON THE PERIODIC SYSTEM OF ELEMENTS. S. V. Ermakov and B. M. Tsarev. Radiotekhn. i Elektron., 7: 2102-4(Dec. 1962). (In Russian)

Thermionic emissions of $CrSi_2$, CrSi, Cr_3Si, $MoSi_2$, $NbSi_2$, $ReSi_2$, $TaSi_2$, VSi_2, WSi_2, and $ZrSi_2$ were studied, and melting points were found. The emission current density and the work functions at various temperatures were measured and tabulated. (R.V.J.)

25813 THERMOEMISSION OF URANIUM CARBIDES AND ZIRCONIUM CARBIDES AND THEIR SOLID SOLUTIONS. B. S. Kul'varskaya, V. A. Grodko, B. N. Markar'yan, and I. M. Rubanovich (Kiev State Univ.). Radiotekhn. i Elektron., 8: 675-9(Apr. 1963). (In Russian)

Thermoelectric properties of ZrC–UC solid solutions were studied, and the yield φ_0 and constant A were determined by means of Richardson's straight lines. The yield, φT at $A_0 = 120$ amp/cm^2 grad^2, and temperature coefficients were estimated. Cathode thermoemission was stable up to

2000°K. Systematic cathode adjustments were made in order to obtain consistent results. (tr-auth)

25814 VELOCITY AND PRODUCTS OF THORIUM CARBIDE THERMOCATHODE EVAPORATION. B. I. Mikhailovskii and R. I. Marchenko (Kiev State Univ.). Radiotekhn. i Elektron., 8: 680-3(Apr. 1963). (In Russian)

Contact potential and mass spectrometric analysis indicate that the ThC_2 evaporation rate is subordinate to the formula $N = Ae^{-Q/kT}$ at cathode temperatures from 1800 to 2050°K. Thermal dissociation of ThC_2 molecules was not observed at $A = 5.4 \times 10^{25}$ mol/cm^{2}sec = 2.3×10^4 g/cm^{2}sec and Q = 4.8 ev. (tr-auth)

25815 EXTERNAL PHOTOEFFECTS AND SECONDARY ELECTRON EMISSION OF BERYLLIUM OXIDE COATING ON BERYLLIUM BRONZE. A. M. Tyutikov. Radiotekhn. i Elektron., 8: 691-7(Apr. 1963). (In Russian)

Spectral characteristics of the external photo effects on a beryllium oxide coating on various beryllium bronze preparations are described. Effects of beryllium and oxygen on the secondary electron emissions from beryllium bronze were analyzed, and the lack of correlation between the concentration of admixtures in the emitter and the maximum electron emission coefficient was noted. (tr-auth)

25816 STRUCTURE AND SECONDARY ELECTRON EMISSION FROM ACTIVATED BERYLLIUM BRONZE. A. M. Tyutikov. Radiotekhn. i Elektron., 8: 698-708 (Apr. 1963). (In Russian)

Structural characteristics and secondary emission properties of oxidized beryllium bronze were studied in a spherical condenser at 5×10^{-7} to 2×10^{-6} mm Hg. Factors inducing variations of secondary emission in dry and humid air are analyzed. (R.V.J.)

25817 SEMICONDUCTING REGION OF YTTERBIUM. P. C. Souers and G. Jura (Univ. of California, Berkeley). Science, 140: 481-3(May 3, 1963). (UCRL-10715)

The resistivity of elemental Yb at room temperature rises, by a factor of 11, to a maximum at a pressure of 40 kilobars; a further increase in pressure causes a polymorphic transition; the new phase has a resistivity 80% of that of the metal at 1 atmosphere. In the temperature–pressure diagram, the phase boundary has a negative slope. The phase boundary, determined from –190 to 360°C, is a straight line that may be extrapolated nearly to the known α-β transition at 1 atm. Between the transition pressure and 20 kbar, the lowest pressure at which the measurements were made, Yb behaved as a semiconductor. The temperature coefficient of resistance is negative; at constant pressure, the resistivity shows the exponential temperature dependence characteristic of a semiconductor. The parameter in the exponential would correspond to an energy gap 0.015 ev at 20 kbar, an increase with pressure to a maximum of 0.080 ev at 37 kbar, and then a decrease to 0.05 ev at 45 kbar. (auth)

25818 THE CRYSTAL STRUCTURE OF THE HIGHEST BERYLLIDES OF MOLYBDENUM, WOLFRAM, AND RHENIUM. N. N. Matyushenko, L. F. Verkhorobin, N. S. Pugachev, and N. V. Sivokon' (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Soviet Phys.-Cryst. (English Transl.), 7: 701-3(May-June 1963).

The stoichiometric formula of the highest beryllides of Mo, W, and Re is established as ABe_{22}, and a crystal structure determination of $MoBe_{22}$ is carried out. The space group is O_h^7–Fd3m, a = 11.636 ± 0.002 Å, Z = 8, $\rho_{20°C}$ = 2.51 ± 0.02 g/cm^3. The compound $MoBe_{22}$ is isomorphous with $ZrZn_{22}$. (auth)

25819 MAGNETIC STRUCTURE OF YTTRIUM FERRITE. Yu. S. Kuz'minov, I. I. Yamzin, and N. V. Belov (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 7: 765-7 (May-June 1963).

Neutron diffraction measurements were made on polycrystalline $Y_3Fe_5O_{12}$ at room temperature and at 300°C. The intensities are in good agreement with the values calculated from Néel's model. (D.L.C.)

25820 PHYSICAL METALLURGY OF MAGNESIUM AND ITS ALLOYS. Johs B. Oestby. Tidsskr. Kjemi, Bergvesen Met., 22: 189-93(Nov. 1962). (In Norwegian)

A brief description is given of properties of magnesium and its common alloys, which are of importance to the practical use of these materials. The quantitatively most important alloys are based on solubility of magnesium and aluminum in each other. At the side of these alloys aluminum-free alloys are found which contain zinc, zirconium, manganese, thorium, and other elements with valuable properties but available at higher prices. (auth)

25821 NIOBIUM–RUTHENIUM ALLOYS. Ernst Raub and Walter Fritzsche (Forschungsinstitut für Edelmetalle und Metallchemie, Schwäbisch Gmünd, Ger.). Z. Metallk., 54: 317-19(May 1963). (In German)

The system niobium–ruthenium was investigated by x-ray diffraction and microscopy. The tetragonal phase was found to be homogeneous between 41 and 46.5 at. % Ru. A second phase with a face-centered rhombic unit cell was observed between about 47 and 58 at. % Ru. The limits of mutual solubility were found at 17 at. % Nb and 40 at. % Ru, respectively. The ruthenium solid solution exhibited a B2-type superlattice extending over part of the concentration range in analogy to the system vanadium–ruthenium. (auth)

25822 SYSTEMATICS FOR STRUCTURAL TYPES OF INTERMETALLIC COMPOUNDS. P. I. Kripyakebich. Zh. Strukt. Khim., 4: 282-99(Mar.-Apr. 1963). (In Russian)

Coordination polyhedrons are described for various intermetallic crystal structures. The review includes an extensive list of references. (R.V.J.)

25823 THE EFFECTS OF RARE EARTH ELEMENTS ON THE RECRYSTALLIZATION BEHAVIOR OF ZIRCONIUM. Henry LeRoy Andrews. Thesis, Troy, N. Y., Rensselaer Polytechnic Inst., 1962. 126p.

The recrystallization behavior of Zr as affected by various rare earth alloy additions was investigated. Recrystallization temperatures and activation energies for recrystallization were determined. Thirteen dilute alloys in the systems Nd-, Gd-, Tb-, Dy-, and Lu-Zr were prepared. The progress of recrystallization was monitored by Vickers pyramid hardness determinations and metallography. The arbitrary value of 50% softening was the "recrystallization temperature" variable investigated. Extensive softening occurred during recovery in every system, and the recrystallization behavior was likewise similar in all systems. Increasing the concentration of alloying additions or alloying an element of larger atomic radius in all instances caused a rise in the recrystallization temperature. The recrystallization temperatures and activation energies for recrystallization were correlated with a "normalized" total strain parameter. The extreme atom size differences of solute to solvent determined the extent of variation in the recrystallization behavior of Zr, and the other normal alloying variables (valency, electronegativity, crystal structure) were not operative in the Zr-rare earth systems. (Dissertation Abstr.)

25824 MAGNETIC PROPERTIES OF SOME INTRA-RARE EARTH ALLOYS. Paul Edward Roughan. Thesis, Ames, Iowa, Iowa State Univ. of Sci. and Tech., 1962. 111p.

Four intra-rare-earth alloys exhibiting the crystal structure of Sm have been prepared, and the magnetic properties of these alloys have been investigated over the temperature range 4.2 to 300°K. The alloys examined, with their compositions given in atomic percentages, were: 30.1 La–69.9 Gd, 70.0 Nd–30.0 Y, 55.0 Ce–45.0 Y, and 63.0 Nd–37.0 Tm. The alloys investigated represented 3 possible types of Sm structure phases, i.e., the 3 possible combinations of light, heavy, diamagnetic, and paramagnetic rare earth metals which would afford a measurable paramagnetic susceptibility. All of the samples obeyed the Curie-Weiss law over the range 77 to 300°K, except for the La–Gd alloy, in which the curve of $1/\chi$ vs T was a straight line only from 155 to 300°K. The measured susceptibilities over this range were in good agreement with theory for the Nd–Y and Nd–Tm alloys, although the values for the latter were consistently low by approximately 7%. The La–Gd sample showed the largest deviation from the theoretical values, the susceptibility indicating that electron transfer may have occurred in this alloy, altering the normal $S_{\frac{7}{2}}^{8}$ configuration of the Gd^{3+} ion to that of the Tb^{3+} ion, i.e., F_6^7. The data for the Ce–Y alloy were lower than those expected from theory, and decreased even more as the temperature was lowered, indicating the probability of a Ce^{3+}–Ce^{4+} transition on cooling. Antiferromagnetism was observed in all 4 alloys at low temperatures, the Néel points being 155°K in La–Gd, 37°K in Ce–Y, 34.5°K for the Nd–Y alloy, and 28.5°K for the Nd–Tm sample. For the former two alloys, the susceptibility remained constant below the Néel point, down to 7°K in La–Gd, and to 26°K in the case of the Ce–Y alloy. The latter alloys exhibited maxima in their susceptibilities at the Néel points, and conformed quite well with the Néel-Van Vleck theories of antiferromagnetism. (Dissertation Abstr.)

25825 A RADIOACTIVE TRACER DEW POINT METHOD FOR MEASURING VAPOR PRESSURES OF BINARY ALLOYS. George John Lutz. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1962. 77p.

A dew point method for measurement of vapor pressures in alloy systems was developed. This method is based on the observation of condensation by the detection of γ radiation of a radioisotope of the more volatile component of the alloy. The isotope used was Zn^{65} obtained by neutron bombardment in a nuclear reactor. Alloy systems studied were Al–Zn, Yt–Zn, and Th–Zn. The dew point cell and furnace are described. The condensing tracer Zn was detected with a 1-in. NaI(Tl) crystal and photomultiplier tube connected to a scaling unit. A discriminator unit in the counting circuit augmented the sensitivity of detection. The dew point temperatures obtained were used to construct equations relating the vapor pressure of Zn over the alloys to temperature. The calculated pressures were used to calculate thermodynamic activities for the systems. From these activities integral thermodynamic properties of the phases studied could be calculated. In the Al–Zn system the free energy, enthalpy and entropy of mixing were calculated. A number of compounds exist in the Yt–Zn and Th–Zn systems, and the free energy, enthalpy, and entropy of formation of these compounds were calculated. (M.P.G.)

25826 SUPERCONDUCTING ENERGY GAP OF TANTALUM, VANADIUM AND NIOBIUM. Moises Levy. Thesis, Los Angeles, Univ. of California, 1963. 138p.

Ultrasonic attenuation measurements on single crystal cylinders axially oriented along the (110) crystallographic direction were used to determine the temperature dependent superconducting energy gap, $2\epsilon_0(T)$ of three transition metals, vanadium, niobium, and tantalum. Longitudinal wave measurements were made on two samples of vanadium and two samples of tantalum. Transverse wave measurements were made on one niobium sample and one of the vanadium samples. The zero temperature energy gap was found to be $3.5 \pm 0.3\ kT_c$ and $3.5 \pm 0.1\ kT_c$ for the two vanadium samples, respectively; $3.4 \pm 0.3\ kT_c$ and $3.5 \pm 0.1\ kT_c$ for the two tantalum samples, respectively; $3.5 \pm 0.3\ kT_c$ for the niobium sample. These values were computed by averaging the results obtained from 200 to 300 experimental points. They are in agreement with the Bardeen, Cooper, and Schrieffer result, which states that $2\epsilon_0(0)$ should be equal to $3.5\ kT_c$ for all superconductors. The dependence of the normalized energy gap on the reduced temperature of these five metal samples is closely predicted by the BCS theory. These experiments were performed within the frequency range 43 to 450 Mc, and in all of them, the product of the ultrasonic wave vector times the electron mean free path, ql, was smaller than one, since $\hat{l}$ was very small in these samples. In contrast with previous results of other investigators obtained in other metals in the ql range larger or equal to one, where the ultrasonic attenuation constant experiences a sharp drop at the transition temperature when the crystal goes superconducting, the transverse measurements, in the ql range smaller than one, showed no such drop. A theory is proposed for explaining the absence of this drop in the transverse wave measurements and the fact that both transverse and longitudinal attenuation measurements appear to obey the result that BCS obtained for electron-phonon interaction for longitudinal waves in the ql range much larger than one. The temperature dependence of the attenuation in the superconducting state showed small oscillations. It was found that the amplitude of these seems to be independent of the total attenuation and consequently is a small effect for very pure samples. Moreover, evidence was collected to show that these oscillations are not an inherent property of the superconducting state but are probably associated with acoustic modes of wave propagation. (Dissertation Abstr. 23: May 1963)

25827 THE EFFECT OF INTERSTITIAL ATOM-DISLOCATION INTERACTIONS ON THE DEFORMATION BEHAVIOR OF SOME BODY-CENTERED-CUBIC METALS. Benjamin Abbott Wilcox. Thesis, Stanford, Calif., Stanford Univ., 1962. 176p.

The strain aging behavior of arc-melted niobium and tantalum, 1020 steel, and hydrogenated niobium was investigated using yield-point return and dynamic modulus of elasticity measurements to study the aging process. Comparison of activation energies for strain aging with those for interstitial diffusion revealed that hydrogen was responsible for dislocation locking in niobium, and probably in tantalum, in the temperature ranges studied. The studies on 1020 steel reconfirmed the fact that nitrogen and carbon cause dislocation locking in mild steel, and validated the accuracy of the yield point return and dynamic modulus techniques for studying the strain aging process. The elastic interaction, U, between hydrogen atoms and dislocations in niobium is quite small as compared to U for carbon in alpha-iron (U for H in Nb $\approx$ 0.03 ev, U for C in α–Fe = 0.5 ev). It is suggested that there may be a significant electrical interaction between hydrogen atoms and dislocations in Nb. It was concluded that hydrogen locking of dislocations in Nb occurs to some extent by Cottrell-Bilby segregation, but probably more strongly by the formation of micropre-

cipitates along dislocation lines. Harper's modification of the Cottrell-Bilby analysis was applied to the dynamic modulus strain aging data for 1020 steel, niobium, and hydrogenated niobium to determine dislocation densities in these materials. Densities so determined were compared with values obtained by direct observations using etch-pitting techniques. In order to obtain a measure of the degree of dislocation locking in niobium as a function of hydrogen content, the lower yield stress of electron beam melted niobium was measured as a function of grain size and hydrogen content (7, 15, 61, and 78 ppm H). In the Petch equation, $\sigma_y = \sigma_i + k_y d^{-\frac{1}{2}}$, the parameter k_y, a measure of the dislocation locking strength, was found to increase with increasing hydrogen content. The lattice friction stress, σ_i, decreased with increasing hydrogen content, probably because the hydrogenating treatments caused the removal of oxygen and nitrogen from solid solution. The effective surface energy, γ, for crack propagation in hydrogen embrittled niobium (367 ppm H) was found to be less than 1410 ergs/cm^2 using Cottrell's fracture criterion. Using Johnson's ductile cleavage fracture theory, γ was found to be less than 4650 ergs/cm^2. (Dissertation Abstr. 23: May 1963)

Radiation Effects

Refer also to abstracts 26081, 26093, 26116, 26137, 26138, 26139, 26140, 26141, 26142, 26143, 26144, 26145, 26146, 26149, 26150, 26151, 26152, 26153, 26154, 26160, 26161, 26163, 26164, 26165, 26166, 26167, 26169, 26170, 26171, 26172, 26177, 26178, 26179, 26181, and 26186.

25828 (GA-4190) TRANSIENT RADIATION EFFECTS ON ELECTRONIC PARTS. Fourth Quarterly Progress Report, January 1, 1963 through March 31, 1963. Report No. 4. G. R. Hopkins, A. L. A. Weiman, and D. E. Willis (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 30, 1963. 23p.

Work continued on the measurement of radiation effects on coaxial cable. Information is based on irradiating about 180 cm of RG 58 cable having a solid polyethylene dielectric. About 100 measurements were processed, producing details on the ratio of charge per incident dose. The apparatus required to test small passive electronic components in vacuum in gamma-neutron fields was built and tested. Improvements in vacuum conditions are required. Sixteen capacitors were tested under irradiation; results will be discussed in a later report. The conductivity induced in RG 58 cable as a result of gamma irradiation was found to vary approximately as the 0.55 power of the dose rate over a range of 0.36 to 7×10^4 rads/sec. For a given dose rate, the induced conductivity is constant for any voltage applied to the cable within the range of −300 to +300 volts. The gamma induced secondary emission is constant over a measured dose rate range of 0.37 to 10^8 rads/sec. Thus, gamma photoconductivity is important at low dose rates and secondary emission is important at high dose rates. The secondary emission signals resulting from fast and thermal neutron irradiation are opposite in polarity to those from gamma irradiations. The neutron induced conductivity is not as sensitive to dose rate as is the conductivity induced by gamma irradiation. Further tests on initial cable effects indicate that an initial dose of 1000 rads or 10^{12} nvt results in an initial fixed charge on the cable ranging from $+1 \times 10^{-9}$ to -2×10^{-9} coulomb. This initial charge depends on type and rate of irradiation, and on applied voltage. After this charge is deposited, the remaining signal is proportional to dose. (auth)

25829 (GEAP-3771-8) HIGH PERFORMANCE UO_2 PROGRAM. Quarterly Progress Report No. 8, January–March 1963. B. Weidenbaum (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 15, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 100p. (EURAEC-642)

The post-irradiation examination of two fuel rods is in progress from the group of five that were irradiated. Direct fission-gas pressure measurements are available for the two rods being examined to determine the relation between fission-gas release and fuel-control temperature or fraction of the fuel above the crystallization temperature. The second powder-filled fuel assembly, EPW 6/8A, for the GETR Pressurized Water Loop which contained two swaged rods and two vibratory compacted rods, each type to operate at 600,000 and 800,000 Btu/hr-ft^2, experienced a rod failure while the reactor was coming to power during a programed start-up. The failure occurred in the swaged 800,000 rod (located furthest from the core center), whereas the vibratory compacted 800,000 rod operating at a higher heat flux at the time of failure did not show any increase in diameter. A cored pellet fuel rod assembly, EPT-12, with rods designed to operate in excess of 1.3×10^6 Btu/hr-ft^2 was irradiated without incident for the equivalent of nineteen days at full GETR power. The irradiation of EPT-12 was continued through this cycle without difficulty for approximately an additional twenty-six days at full power. Fuel assembly EPT-12 which contained UO_2 pellets with a 0.140 inch diameter central hole was irradiated with the highest power rated rod attaining a calculated peak surface heat flux of 1.4×10^6 Btu/hr-ft^2. The irradiation of fuel assembly EPT-12 was continued and reached an average burnup of over 5000 Mwd/Te at the end of the cycle. On the basis of high temperature, thermal conductivity data, over 70% of the UO_2 cross section is molten in the peak heat flux zone with only a 0.040 inch solid UO_2 band adjacent to the cladding during operation of the highest rated rod in ETP-12. A second powder fuel assembly, EPT 6/8A, containing both swaged and vibratory compacted UO_2 fuel rods designed to operate at 600,000 and 800,000 Btu/hr-ft^2 experienced a cladding failure in the swaged rod with the higher power rating before the reactor reached full power. Both swaged rods in EPT 6/8A had considerable clad swelling and could not be removed from the assembly; neither vibratory compacted rod showed any measurable clad swelling. Failure occurred in the swaged rod with apparent clad melting at the peak heat flux region with the rod operating at a heat flux of 750,000 Btu/hr-ft^2, the vibratory compacted rod at that time had a heat flux of over 800,000. A mechanism for the clad melting, either molten UO_2 reaching the clad or a heat transfer "burnout," is being looked for in the examination of the fuel rod. The cause of the failure in the swaged fuel rod in the first powder assembly at a point below the peak heat flux was apparently due to a localized weakness in the cladding. After irradiation of the EPT-COM assembly, for a full GETR cycle, the rod which operated at a peak heat flux 1,000,000 Btu/hr-ft^2 had clad swelling to the extent of 13 mils, while the 1,100,000 rod did not show any diameter increase. The reason for this anomalous result is not known. Post irradiation examination of rod 10D from the EPT-10 assembly indicated a

strong possibility that it was defected during operation. Preliminary analysis of the fission gas release data from the solid pellet fuel assemblies irradiated in the program showed an unexpectedly low release for the heat fluxes at which the rods operated. On the basis of the work on the first three Trail Cable pellet capsules, only a slight upturn in the effective thermal conductivity of UO_2 was found in the temperature range 1950 to 2450°C. A value of 86 ± 3 w/cm was obtained for $\int_0^{T\ melting} kd\theta$ for UO_2 from an analysis of five different cross sections in which melting occurred in the Trail Cable capsules. A physics analysis is being made of the effect on the reactivity of a large reactor core that would result from the redistribution of fuel when UO_2 melts. A comparison was made between the microstructures of the natural UO_2 pellets and enriched pellets. The enriched specimens showed larger voids, more irregularly distributed porosity, and larger regions with high density before heat treatment, and had some areas with very large variation in grain size after heat treatment. Experimental results obtained with encapsulated UO_2 showed that the data obtained previously with an open system were influenced by the vaporization of UO_2. Less scatter in the data was obtained when the grain growth experiments were conducted with encapsulated specimens instead of an open system. Calibration runs were made for the system in which annular UO_2 pellets are heated from the center. No difficulty was encountered in reaching the melting point at the inner surface of the pellet. (auth)

25830 (HW-SA-3000) THE EFFECTS OF NEUTRON FLUX AND REACTOR ENVIRONMENTS ON STAINLESS STEELS. Spencer H. Bush and John C. Tobin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1963. Contract AT(45-1)-1350. 57p.

The performance of ferritic, martensitic, austenitic, and precipitation hardening stainless steels when exposed to neutrons is reviewed. In addition, the effects of the reactor environment, whether water, gas, or liquid metal, are considered where neutron flux directly influences the interaction between the stainless steel and its environment. The effects of neutron irradiation on the mechanical properties of stainless steels are examined based on post-irradiation tests. Generally, exposure to neutron flux increases the yield strength substantially more than it does the ultimate tensile strength. This is accompanied by marked decreases in ductility. Uniform deformation becomes extremely small after exposures in the range 10^{20} to 10^{21} nvt. The dynamic properties of the stainless steels such as creep, stress rupture, and low cycle fatigue are reviewed, based on the limited data available. The effects of stress application to stainless steels while exposed to neutrons are also discussed. Changes in microstructure of the stainless steels were observed. The changes are considered on the bases of possible kinetic effects induced by temperature, time, neutron flux, and reactor environment. Direct reactions of the stainless steels with the reactor environment are also considered, where the neutron field appears to play a substantial role in addition to temperature-time effects. Indirect effects of a neutron environment are also discussed. (P.C.H.)

25831 (PAN-371/V) SOME PROBLEMS OF GAS ADSORPTION ONTO THE SURFACE OF SOLIDS. Elwira Herczyńska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Nov. 1962. 18p.

A brief review is given on previous work on gas adsorption on the surface of solids. The effects of radiation on the adsorption from aqueous solutions is explained as a result of the adsorption and desorption of O during the irradiation of a solid. (P.C.H.)

25832 (VDIT-16(3.2)) RADIATION EFFECTS ON SOLID, URANIUM BASED NUCLEAR FUEL MATERIALS, Vol. 3, No. 2. A Bibliography. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). May 1963. 54p.

References (87) on radiation effects on uranium, alloys, oxides, refractory compounds, and dispersion fuels are given to reports, books, and U. S. and foreign journals published from August 1961 through 1962. Separate author, report number, and journal indexes are included. (P.C.H.)

25833 COMPARISON OF THE EFFECTS PRODUCED BY IRRADIATION WITH FAST NEUTRONS AND THERMAL NEUTRONS ON THE YELLOW SERIES OF THE ABSORPTION SPECTRUM OF CUPRITE. Serge Nikitine, Nichel Grosmann, and Yves Droulers (Faculté des Sciences, Strasbourg and CEN, Grenoble, France). Compt. Rend., 256: 3636-8(Apr. 22, 1963). (In French)

The electric fields and the internal stresses created in cuprite by reactor irradiation are caused by neutrons with energy higher than 0.5 ev. (tr-auth)

25834 INFLUENCE OF CRYSTALLITE SIZE ON THE THERMAL CONDUCTIVITY OF IRRADIATED POLYCRYSTALLINE GRAPHITE. I. B. Mason and R. H. Knibbs (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 198: 850-1(June 1, 1963). (AERE-R-4184)

The thermal conductivity of many forms of carbon and graphite decreases if irradiated with neutrons of sufficiently high energy. The electronic component of this conductivity, before and after irradiation, amounts to less than 1% of the measured values. The decrease in thermal conductivity due to neutron irradiation is attributed almost entirely to extra phonon scattering by irradiation-produced defects. A mathematical term in the Debye expression for thermal conductivity is presented for correction of the equation for the influence of crystallite size on the thermal conductivity of irradiated polycrystalline graphite. (C.H.)

25835 LOW-TEMPERATURE COLORATION IN KCl AND KBr NEAR THE FUNDAMENTAL EDGE. Clifford C. Klick and David A. Patterson (Naval Research Lab., Washington, D. C.). Phys. Rev., 130: 2169-76(June 15, 1963).

Crystals of KCl and KBr were cooled with liquid helium, x rayed, and investigated for coloration near their fundamental absorption edge. Three bands are seen in both materials with the largest band closest to the fundamental edge. In KBr the first band is broad and peaks at 2300 Å, the second is the α band at 2020 Å, and the third, called the γ band, is at 1895 Å. The areas of the three bands with respect to the F band are, respectively, 1:8:20. In KCl similar bands are found at 1940 Å, 1790 Å, and 1640 Å. The areas are, respectively, 1:6:16 as large as the F band. The α and γ bands are also found in KBr:H on bleaching in the U band, and the α and γ bands have similar bleaching rates on warming. It is concluded that the γ band arises when an exciton is created at a slightly larger distance from the negative-ion vacancy than is the case for the α band. It is proposed that the centers responsible for the first band, the α and γ bands, and the F and H bands all are formed from the creation of Frenkel defects but differ in the distance of separation of the interstitial and vacancy and in the resulting ability to trap electrons and holes. With this assumption the x-ray energy dissipated in producing a Frenkel defect is 240 ev for KBr and 450 ev for KCl using 50-kv x rays. (auth)

25836 RECOVERY STUDY IN PURE AND ALLOYED ALUMINUM FOLLOWING ELECTRON IRRADIATION. A. Sosin and L. H. Rachal (Atomics International, Canoga Park, Calif.). Phys. Rev., 130: 2238-48(June 15, 1963).

Pure aluminum and slightly alloyed aluminum samples were bombarded with electrons near 4.2 and 78°K. The electrical resistivity increases introduced by the radiation were observed to recover in three stages: Stage I, below 50°K, Stage II centered at about 140°K, and Stage III, between 190 and 250°K. Stage III follows second-order kinetics with an activation energy of 0.45 ± 0.01 ev; Stage II follows close to first-order kinetics with an activation energy of 0.22 ev. The magnitude of Stage II depends sensitively on the amount and type of solute atoms in the lattice. Stage III is larger in alloyed aluminum than in pure aluminum and is shifted to lower temperature. The enhanced magnitude and the temperature shift are consistent with the observed second-order kinetics, indicating that the effect of alloying is to increase the number of defects that migrate in Stage III. A two-interstitial model, previously proposed to explain recovery in copper following irradiation, appears to account for these observations most satisfactorily. (auth)

25837 ENERGY FOR ELECTRON-HOLE PAIR GENERATION IN SILICON BY α PARTICLES. G. Fabri, E. Gatti, and V. Svelto (Laboratori CISE, Milan). Phys. Rev., 131: 134-6(July 1, 1963).

The mean energy ϵ_m for electron-hole pair generation in silicon by α particles was measured at different temperatures. For a given temperature, this value was obtained by extrapolating to infinite collecting electric field the actual data at various finite fields. The experimental values are reported as a function of the forbidden energy gap, and compared with a theoretical expression due to Shockley. (auth)

25838 LOW TEMPERATURE ANNEALING SPECTRUM OF ELECTRON-IRRADIATED GOLD AND CADMIUM. Walter Bauer. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 51p.

The resistivity annealing spectrum from 8 to 51°K of the damage produced by a flux of 7.5×10^{17} 3-Mev electrons/cm^2 on 99.999% pure gold and cadmium was studied. The total damage and residual resistivity for gold was 8.5×10^{-9} and 3×10^{-9} ohm-cm, and for cadmium 2.32×10^{-9} and 5.3×10^{-9} ohm-cm respectively. The gold activation energy spectrum was derived directly from the isothermal annealing curves. The spectrum consists of at least nine peaks, with 22% of the damage annealing out up to 51°K. These results confirm earlier suggestions that the radiation damage in gold is basically different from that of copper and silver. In connection with the amount of low-temperature annealing, it is thought that focussing and interstitial clustering is important. Deviations from Mathiesson's rule for gold and cadmium are in qualitative agreement with theory. Only qualitative agreement with an earlier experiment on the annealing of cadmium can be confirmed. (Dissertation Abstr. 23: May 1963)

25839 PARAMAGNETIC RESONANCE OF X-IRRADIATED SINGLE CRYSTALS OF ROCHELLE SALT. Grace Charbonnet Moulton. Thesis, Tuscaloosa, Ala., Univ. of Alabama, 1962. 41p.

The electron-spin resonances of single crystals of Rochelle salt and deuterated Rochelle salt irradiated with 40-kv x rays have been studied as a function of orientation of the crystal in the magnetic field. The spectra are time dependent, and by studies of the decay of the spectra it has been found that 3 kinds of centers are present. In Rochelle salt, one of these gives rise to an intense doublet which decays rapidly, another to a doublet which grows and then decays, and the third is an 8-line spectrum which grows and is stable. It is shown that the waters of hydration play an important role in the kinetics of the growth and decay of the centers. The stable spectrum has been analyzed, and it is concluded that 2 of the lines arise from breaking one of the C–H bonds. This doublet is slightly anisotropic, and arises from hyperconjugation to the proton on the adjacent carbon and dipolar coupling between it and the large spin density on the carbon. A second pair of lines arises from breaking the other C–H bond, and since the hydrogens are not equivalent, this pair has a different splitting. The other 2 pairs are shown to be couplings to either OH or water of hydration hydrogens. (Dissertation Abstr.)

25840 POLYMERIZATION PROCESS. Peter Joseph Vermont, James Agius and Eric Bertram Evans (to Esso Research and Engineering Co.). U. S. Patent 3,092,563. June 4, 1963. Priority date Oct. 12, 1955, Great Britain.

Mixtures containing unsaturated nitrogenous bases, e.g., amines, pyridines, pyrimidines, etc., are very difficult to polymerize using peroxy catalysts alone. However, the polymerization may be attained by exposure to high-energy ionizing radiations. The resulting polymeric products may be used as detergents and viscosity-index and pour-point improvers in lubricating oils. (D.L.C.)

25841 IRRADIATION OF WAX. Bertrand W. Greenwald (to Cities Service Research and Development Co.). U. S. Patent 3,092,564. June 4, 1963. Filed Mar. 8, 1960.

A process is given for improving the gloss stability of a wax coating composition which consists of paraffin wax and 0.1 to 50 wt % microcrystalline wax. The process comprises subjecting the composition to between 10^7 and 10^9 r of gamma rays. The resulting composition may be used to prepare waxed paper and the like. (D.L.C.)

PHYSICS

General and Miscellaneous

Refer also to abstracts 25275 and 26458.

25842 (AAEC/TM-190) A 1620 FORTRAN PROGRAMME FOR THE CALCULATION OF BRAGG ANGLES FOR USE IN POWDER X-RAY DIFFRACTION INVESTIGATIONS. D. G. Walker (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Apr. 1963. 5p.

An IBM 1620 program is described that calculates the Bragg angles for cubic, hexagonal, and tetragonal crystal systems for use with powder x-ray diffraction techniques. Allowance is made for absent reflections in the case of face- and body-centered cubic and close-packed hexagonal materials. (auth)

25843 (AD-282296) RESEARCH AND INVESTIGATION OF MATERIALS FOR LASER APPLICATIONS. Interim Engineering Report, May 1–July 31, 1962. K. A. Yamakawa (Electro-Optical Systems, Inc., Pasadena, Calif.). Aug. 13, 1962. Contract AF 33(657)-8918. 37p. (EOS-3110-Q-1)

Rare earth chelates were synthesized and purified by described techniques. The chelates were investigated for fluorescence at room and at liquid nitrogen temperature in the pure state and dissolved in liquid and plastic hosts. Fluorescence was observed in the case of Eu^{3+} and Sm^{3+} for a tris benzoyl acetonate dihydrate and a tris dibenzoyl methide. No fluorescence was observed in the chelates of Nd^{3+}, Tm^{3+}, and Yb^{3+} using the above ligands. Specific absorption coefficients of the complexing agents were measured and found to be very high. Some work was done on the growth of single-crystal solid solutions of chelates in organic crystals. The problem of solubility was pointed up since very low doping levels (about 10^{-3}%) were obtained. Molecular organic crystals, neutral chelates, plastics, and glass (Vycar) were examined as host materials for the rare earth chelates. Vycar, particularly, was investigated, and Nd doped into porous Vycar was observed to fluoresce. (auth)

25844 (AD-402124) LONG LIFE CLOSED LOOP MHD RESEARCH AND DEVELOPMENT UNIT. Interim Scientific Report No. 4, December 15, 1962 to March 15, 1963. (Westinghouse Electric Corp., Pittsburgh). Mar. 15, 1963. Contract AF 33(657)-8311. 99p.

Problems of assembly and preliminary testing of the various portions of the magnetohydrodynamic (MHD) loop are discussed. Topics covered include: refinements in design and instrumentation, safety considerations, conductivity probes, microwave diagnostics for MHD plasma, argon purge and cooling system for return bend, compatibility of tantalum and cesium, motor section power supply, motor and generator magnets, some generator losses, cesium feed and bleed apparatus test, and Hall voltage guard electrodes. (M.C.G.)

25845 (AD-404255) THERMIONIC CONVERTER SURFACE CONDITIONS. First Quarterly Technical Progress Report, February 15, 1963–April 30, 1963. V. C. Wilson and J. Lawrence (General Electric Co. Research Lab., Schenectady, N. Y.). Contract AF 33(657)-10132. 25p.

A review of the program of work on thermionic converters is presented. A parallel-plane cesium converter having an emitter of niobium carbide and a collector of molybdenum was operated. Comparison was made between its operation and that of a similar converter having a cathode of polycrystalline tungsten. The power output of the niobium carbide converter was considerably lower than with tungsten. (auth)

25846 (AD-405168) SUSCEPTIBILITY IN SEMICONDUCTORS. Final Report, April 1, 1961 to March 31, 1963. A. R. Moore and J. O. Kessler (Radio Corp. of America. RCA Labs., Princeton, N. J.). Contract NONR-3467(00). 49p.

The magnetic moment M of a plasma consisting of holes and electrons generated by light within a cylindrical semiconductor crystal immersed in a magnetic field is discussed. Macroscopic transport equations were used to derive the dependence of M on field strength, mobility, and surface recombination conditions. In the limits of low and high surface recombination the theoretical result demonstrates the transition between transverse equilibrium and pure magnetic confinement. Experiments using germanium and an inhomogeneous magnetic field directly measured the diamagnetic force exerted by the plasma on its scattering medium. An induction method utilizing a uniform magnetic field of strength up to 70 kgauss gave collateral results. The dependence of the moment on magnetic field strength, light intensity, temperature, and surface recombination velocity support the theory. (auth)

25847 (GA-4147) A DIGITAL-COMPUTER CODE FOR THE ANALYSIS OF THERMIONIC NETWORKS. J. H. Broido, C. W. Savery, and W. B. Wright (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 22, 1963. Contract NObs-86221. 81p.

Description of a digital computer code that describes the performance of thermionic diodes in a reactor environment follows a discussion of analytical methods for predicting thermionic network behavior. The calculational procedure used in the code is described; and preparation of input, examples of calculations, the FORTRAN listing of the program, and the data library for W emitters are given. (D.C.W.)

25848 (IFA/FT/43) SUR L'EFFET MÖSSBAUER DANS LES COUCHES MINCES. (On the Mössbauer Effect in Thin Films). A. Corciovei and A. Berinde (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). 1962. 25p.

A theoretical study of the Mössbauer effect in thin films is given. The obtained recoilless emission rate, the so-called Debye-Waller factor, has the form $f(q) = f(\infty)^{c(q)[1+D(q)\cos^2\theta]}$, where $f(\infty)$ is the value of the Debye-Waller factor, which corresponds to the solid body, c(q) and D(q) are two functions which depend on the number q of monatomic layers of the thin film, and θ is the angle between the direction of emission of the radiation and the normal to the thin film. The dependence of the anisotropy coefficient D versus q for various values of the elastic forces in the lattice was studied. The energy shift of the recoilless emitted quantum due to the mass modification of the radiating nucleus was obtained and the result was compared with the corresponding energy shift for the solid body. (auth)

25849 (LADC-5791) TRANSPORT PROPERTIES OF He^3, He^4, H_2, D_2, T_2, and Ne IN THE LIQUID STATE ACCORDING TO THE QUANTUM MECHANICAL PRINCIPLE OF CORRESPONDING STATES. J. F. Kerrisk, J. D. Rogers, and E. F. Hammel (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 21p.

The principle of corresponding states, in which the state variables were reduced by the molecular parameters of the Lennard-Jones two-body interaction potential and the theory was extended to account for quantum deviations from classical behavior, was used to investigate the liquid state transport properties of He^3, He^4, H_2, D_2, Ta, and Ne. The thermal conductivity and viscosity were predicted for the liquid in equilibrium with the vapor along the coexistence curve up to the critical point. The measured positive temperature coefficients of thermal conductivity for the lighter species are consistent with this study. The heavier monatomic species, Ne and Ar, as well as near-spherical molecules such as CH_4 are observed to deviate from the behavior of the diatomic molecules for both transport properties studied. (auth)

25850 (NASA-TR-R-170) AXIAL AND RADIAL MAGNETIC FIELDS OF THICK, FINITE-LENGTH SOLENOIDS. Gerald V. Brown, Lawrence Flax, Eugene C. Itean, and James C. Laurence (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). 1963. 101p.

The axial and radial components of the magnetic field intensity were derived, and numerical results were computed for several combinations of coil thickness and length for two different current-density distributions. The data are presented in tables and sample graphs. (auth)

25851 (NP-12800) THE HYDROGEN ISOTOPES IN THE GASEOUS AND LIQUID STATES (thesis). H. F. P. Knaap (Leiden. Universiteit). May 30, 1962. 68p.

The second virial coefficients of H_2, HD, and D_2 were measured at low densities in the temperature region 20–70°K using a differential method. At higher temperatures good agreement with existing data was found. A further check on the isotherm determinations at 20°K was obtained by investigating the second virial coefficient for mixtures with He. A difference in the second virial coefficient between ortho and para H_2 of the order of 1% was found. It is shown that such a difference is expected from the small difference in polarizability. (C.E.S.)

25852 (NP-12877) RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM. Quarterly Progress Report No. 1, December 16, 1962–March 15, 1963. R. Novick (Columbia Univ., New York. Columbia Radiation Lab.). Contract DA-36-039-SC-90789. 54p.

A detailed study was made of the metastable lithium atom. The threshold energy production cross section and lifetime are 56 ev, 10^{-19} cm^2, and 5 ± 1 μsec, respectively. These values are in reasonably good agreement with the theoretical calculations. The fine structure splitting of the 3P term of the lithium atom was determined by level crossing spectroscopy. The observed interval is 2880 Mc/sec and is about 12% smaller than the corresponding splitting. Precise knowledge of fine structure will provide a critical test of three electron wave functions. The spin, magnetic moment, and quadrupole moment of Cd^{113m} were determined by optical double resonance. Computational techniques were developed for the evaluation of fine structure corrections to the level crossing fields in (sp) configurations. A new electric resonance molecular beam apparatus was constructed and will be used for the study of molecular structure. A new high temperature microwave absorption spectrometer was constructed and used for the determination of the rotational structure of LiCl. This spectrometer is unique in that it employs a nitrogen buffer gas to reduce the rate of contamination of the microwave windows and Stark plate insulators. An optical maser was used for the precise determination of the frequency shifts of the light scattered by an acoustically excited liquid. (auth)

25853 (PAN-372/V) ADSORPTION OF H^+ AND OH^- IONS ON VARIOUS METALLIC AND OXIDE SURFACES. PART I. THE ISOELECTRICAL POINTS. PART II. THE ADSORPTION ISOTHERMS. Elwira Herczyńska and Krystyna Prószyńska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Nov. 1962.

The isoelectrical points of Al, Fe, Zn, and Ni surfaces are determined and compared with the literature data; the constants entering the adsorption isotherms are computed from the experimental data. 37 references. (auth)

25854 (PAN-381/I-B) LONGITUDINAL MODES OF A LINEAR CHAIN WITH ALL NEIGHBOURS INTERACTIONS. Andrzej Czachor (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1962. 10p.

It has been shown for a monoatomic linear chain that taking into account the interactions with all neighbors, one can obtain the phonon dispersion relations such as in the Einstein and Debye case. (auth)

25855 (PPAD-484D) RANGE AND ENERGY-LOSS ROUTINES: PROGRAM RANGE AND FORTRAN FUNCTION DEDX. J. L. Rosner and R. L. McIlwain (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Mar. 15, 1963. Contract AT(30-1)-2137. 12p.

A program was written that calculates the range of heavy ionizing particles in various media. A FORTRAN function, utilized by the above program, calculates the rate of energy loss in various media. (auth)

25856 (PR-P-56) PHYSICS DIVISION PROGRESS REPORT, OCTOBER 1, TO DECEMBER 31, 1962. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 85p. (AECL-1711)

Research and developments in electronics, general physics, neutron physics, nuclear physics, and theoretical physics are reported. Separate abstracts were prepared for the five sections of the report. (D.C.W.)

25857 (PR-P-56(p.4-18)) NUCLEAR PHYSICS BRANCH. G. C. Hanna (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Previous values of the velocities of Cf^{252} fission fragments were found in error; revised values were obtained by another experiment and fine structure was noted in the mass yield curve. Programs for processing neutron time-of-flight data were written and tested. Tests indicate SF_6 to be an attractive insulating gas for the tandem accelerator, and production of negative heavy ions was studied. Yields of heavy negative ions from accelerated positive ions were found to be greater than negative H atom yields. Nitrogen was successfully accelerated, indicating the existence of negative N ions. Negative C, F, and S beams were found to result from acceleration and breakup of molecular ions. The equilibrium charge distributions for I ions emerging from carbon-foil strippers were measured. From Doppler shift attenuation measurements of γ rays following Coulomb excitation, the lifetimes of the first and second excited states of Cu^{63} and

Cu^{65} were obtained. Estimates of the cross sections and widths of resonances in the $C^{12}(C^{12},\alpha)Ne^{20}$ reaction were obtained. Previously obtained results on the excited states in Cu^{63} and Cu^{65} were compared unsatisfactorily with theoretical predictions of three models that assume excitation of the even-even core and coupling between the core excited states and the odd particle outside this core. An unfruitful search for a predicted 1.86 Mev level in Cu^{63} was conducted. Threshold energies and product half lives for (n,p), (n,α), and (n,2n) reactions in S^{32}, Th^{232}, Al^{27}, Mg^{24}, Cu^{65}, Zn^{64}, Fe^{56}, Co^{59}, and Sc^{45} were measured. (D.C.W.)

25858 (PR-P-56(p.19-33)) GENERAL PHYSICS BRANCH. H. Carmichael (Atomic Energy of Canada Ltd., Chalk River, Ont.).

A neutron monitor several times as efficient as the IGY cosmic neutron monitor was developed. Barometric coefficients of the IGY monitor and the new NM-64 were measured as (0.715 ± 0.009)% and (0.742 ± 0.008)%/mbar, respectively. Corrected neutron data were used to recalculate the diurnal variation amplitudes and phases. Plastic scintillation detectors were operated successfully as a vertical meson coincidence telescope. A study of conversion L-line broadening following the α decay of Bi^{212} due to recoil effects revealed the presence of an additional line due to K-conversion. The effect of penetration matrix elements on L sub-shell conversion line intensity ratios for hindered E1 transitions in Hf^{177}, Lu^{175}, and Lu^{177} was investigated. A solid state detector with reduced sensitivity to background fluctuations was put into use with the $\sqrt{2}\pi\beta$ spectrometer. Gamma ray peaks with a half life of 45 min in Gd^{169} irradiation were assigned to Eu^{169}. Conversion electron spectra of some of the I^{125} γ transitions excited in Xe^{125} decay were measured. Levels and spins were determined. The possibility that the 476 and 482 kev transitions in Ta^{181} are in cascade was examined. Response of a 4π proportional counter to γ rays was measured as a function of energy. Work on gas counters, p-n junction detectors, lithium drifted p-i-n detectors, and lithium drifted Ge detectors is also reported. (D.C.W.)

25859 (PR-P-56(p.35-42)) NEUTRON PHYSICS BRANCH. G. A. Bartholomew (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Incoming energy distributions of mono-energetic neutrons scattered to an energy of 25 and 40.2 mev from liquid Ar at 84.5°K and 550 mm (Hg) were measured for several values of momentum transfer. The intermediate scattering function and the time dependent pair correlation function were obtained. The dispersion relation for several normal modes and for certain modes with wave vectors near the zone boundary was measured in experiments on slow neutron scattering on a highly doped Si single crystal. The gain stability of the NaI spectrometers used in the γ-γ angular correlation apparatus was improved by use of spectrum stabilizers. The sum coincidence technique was used with angular correlations to determine the spins of excited states of Cr^{51}, Cr^{53}, Fe^{57}, and Ni^{59}. Also, six-angle correlations for the 5.96−1.73, 5.65 − 2.02 cascades and the combined cascade 6.45 + 5.96 + 5.65 − 0.37 Mev in Hg^{200} were measured. A double flat crystal diffraction spectrometer was used to measure the wavelengths of the $K\alpha_1$ and $K\alpha_2$ x rays of Ta and W and of the 173 kev γ ray of Ta^{182}. (D.C.W.)

25860 (PR-P-56(p.43-67)) ELECTRONICS BRANCH. P. R. Tunnicliffe (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Equipment for correlation analyses of noisy signals in reactor systems was almost completed. Construction of equipment for the measurement of water film thicknesses in advanced reactor cooling studies proceeded. The design of satisfactory circuits to determine the thickness and thickness fluctuation of water films on mock-up fuel element was demonstrated. The computer for the electronic data analyzing center was obtained and connected to the 900-channel analyzer. Some of its faults were eliminated, and operating experience was gained. Work continued on the design of equipment necessary to add about 10,000 channels of pulse analyzing capacity to the center. A tape recording system is being built for use with the fast-chopper neutron spectrometer to permit analysis of neutron-capture γ spectra as a function of neutron energy. Automatic control and readout equipment for the double crystal γ spectrometer and the $\sqrt{2}\pi\beta$ spectrometer was completed. Fast scaling circuits were designed using Fairchild micrologic elements. Among various miscellaneous items is an 8 Mc/sec ring counter using complementary-pair transistors. A number of power-switching circuits were designed using silicon-controlled rectifiers. These will control a-c currents up to 25 amps. The emission of electrons from metal surfaces in intense γ fields was studied. At 4×10^6 R/hr the emission from brass is equivalent to the thermionic emission at about 1200°K. Equipment and techniques are being developed for studying the semiconductor and thermoelectric properties of materials such as UO_2. Resistors, electrolytic condensers, diodes, transistors, and wafer switches available were evaluated. (auth)

25861 (PR-P-56(p.68-81)) THEORETICAL PHYSICS BRANCH. H. H. Clayton (Atomic Energy of Canada Ltd., Chalk River, Ont.).

The thermal neutron flux in Sb−Be systems was calculated for a range of parameters describing the system. The correction for the effect of an Al container on the fission rate of enclosed U^{238} was derived, and the negative parity states in O^{16} and O^{17} were studied. Numerical solutions for a system of 2 particles in the s-d shell (O^{18}) were found to agree with SU_3 and other calculations. Inelastic neutron scattering cross sections in Rh^{103} were calculated. Activation cross sections for the excitation of isomeric activity in Rh^{103} are given. Work was begun on a high transmission $\sqrt{2}\pi$ spectrometer. The computer program for distorted wave approximation calculations was generalized to include deuteron stripping reactions, and the energy levels of the $f_{\frac{7}{2}}$ nuclei of Ca^{44} and Cr^{52} were studied from the point of view of configuration interaction. Several computer programs were written, and one was rewritten to solve an inhomogeneous multigroup diffusion equation. (D.C.W.)

25862 (R62SD94) THEORETICAL PERFORMANCE FOR MHD GENERATORS UTILIZING NON-EQUILIBRIUM IONIZATION IN PURE ALKALI METAL VAPOR SYSTEMS. F. H. Shair and F. Cristinzio (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Jan. 1963. Contract AF33 (657)-8298. 65p.

Each member of the alkali metal series is investigated to determine the best system for a closed-cycle MHD generator utilizing magnetically induced nonequilibrium ionization. MHD generator performances are calculated for one-dimensional steady-state flows with constant Mach number in which the dimer concentration is neglected. The calculations are for a generator with segmented electrodes. Potassium appears to be the best choice for a 1-Mw gen-

erator operating at total temperatures near 1600°K and total pressures around 20 psia. This choice is based upon considerations of the calculated generator performance, the vapor pressure, and the equilibrium concentration of dimer in the vapor. The calculations show that the performance of an MHD generator utilizing a nonequilibrium condition of the electrons is primarily dominated by the elastic electron-neutral collision cross section. If the elastic electron collision cross section in potassium is 4×10^{-14} cm^2, then magnetic fields of 130,000 gauss will be required to obtain the nonequilibrium conditions necessary to obtain power densities near 1 kw/cm^3 when the Mach number is around 2. However, if the cross section in potassium is near 1×10^{-15} cm^2, then magnetic fields of 12,000 gauss will produce power densities near 1 kw/cm^3 at a Mach of 2. (auth)

25863 (R63SD43) EFFECT OF INDUCED DIPOLE INTERACTION ON THE CROSS SECTION FOR ROTATIONAL EXCITATION BY ELECTRONS. Douglas H. Sampson (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). May 1963. 21p.

A calculation of the inelastic cross section for rotational excitation of homonuclear molecules by impact with slow electrons is performed using the Born approximation. The calculation is similar to that conducted by Gerjouy and Stein except that in addition to the pure quadrupole interaction the induced dipole interaction is included. This results in a significant increase in the rotational cross section, particularly for electron energies $\epsilon_a \geq 0.1$ ev. (The increase for N_2 at $\epsilon_a = 0.4$ ev is by about a factor of 2.) This at least partially accounts for the rise in electron energy loss rates usually attributed entirely to the onset of vibrational excitation. The use of the Born approximation would appear to be less accurate for this problem than previously assumed. This results partially because the induced dipole interaction goes as a higher inverse power of r (r^{-4}) than the pure quadrupole interaction; however, it is partially due to the fact that the distortion of the electron wave function by the spherically symmetric part of the potential should also be considered. (auth)

25864 (SCTM-58-63(91)) ELECTRON CORRELATION EFFECT IN BERYLLIUM (thesis). G. R. Ellison (Sandia Corp., Albuquerque, N. Mex.). Mar. 1963. Contract [AT(29-1)-789]. 250p.

Using a slater-hylleraas four-electron wave function, which included the interelectronic distance of the outer two electrons, the ground state energies of several single nucleus systems are calculated. The correlation between appropriate energies and the interelectronic distance term of the wave function are then examined. (auth)

25865 (TID-18705) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Technical Status Report No. 14. Annual Summary Report, March 1, 1962–February 28, 1963. D. W. Martin, D. S. Harmer, and R. A. Langley (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Mar. 1, 1963. Contract AT(40-1)-2591. 30p.

Final verification of the ionization and charge transfer cross sections for He^+ incident on targets of H_2, He, and Ne was reported. The measurements were extended to targets of Ar, N_2, O_2, and CO. The data were obtained with target gas pressures of 0.5 to 1.0×10^{-4} Torr and incident He^+ energies of 0.15 to 1.0 Mev. A comparison of gross ionization cross sections for He^+ and protons of equal velocity incident on helium and molecular hydrogen was made. New additions to the charge-changing cell and analyzer were also reported. (C.E.S.)

25866 (TID-18752) PHENOMENOLOGICAL EXPRESSIONS FOR THE MAGNETOSTRICTION CONSTANTS OF CUBIC AND HEXAGONAL CRYSTALS. W. E. Coleman and A. S. Pavlovic (West Virginia. Univ., Morgantown). [1963]. Contract AT(40-1)-2839. 12p.

The phenomenological magnetostriction constants are related to the strain dependence of the exchange energy and to the magnetoelastic coupling coefficients, by minimizing the strain dependent free energy of a ferromagnet with respect to strain. Using the molecular field approximation for the exchange energy the forced magnetostriction is related to the strain dependence of the exchange interaction for cubic and hexagonal ferromagnets. Analytical expressions for the experimental data from which the spontaneous magnetostriction constants can be obtained are also given. (auth)

25867 (TID-18768) THE APPLICATION OF STRAIN GAGES TO MAGNETOCALORIC MEASUREMENTS. J. G. Marsh and A. S. Pavlovic (West Virginia. Univ., Morgantown). [1963]. Contract AT(40-1)-2839. 13p.

The magnetocaloric effect was determined in the basal plane of a single crystal of hexagonal gadolinium by means of strain gages. The measurements were made over a temperature range of –70 to 50°C and for magnetic field changes of 0 to 8000, 11300 to 22400 and 19000 to 22400 Gauss. The effect was determined indirectly in that the values for the strains $\Delta L/L$ due to magnetocaloric heating were measured with strain gages and the strain then divided by the corresponding values for the coefficient of thermal expansion to give the change in temperature which occurred in the sample. It is shown that the technique is a very inaccurate one since it depends on having a very accurate result for the coefficient of thermal expansion. The results show that the magnetocaloric effect cannot be measured with any great accuracy by the use of strain gages because the effect must be determined indirectly by dividing the magnetocaloric strain by the coefficient of thermal expansion. In general, the coefficient of thermal expansion cannot be measured accurately in the region where the magnetocaloric effect is significant. (P.C.H.)

25868 (UCRL-10748) MOMENTUM TRANSFER IN HEAVY-ION-INDUCED REACTIONS. Torbjoern Sikkeland and Victor E. Viola, Jr. (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 7, 1963. Contract W-7405-eng-48. 23p.

A three-dimensional fragment-fragment angular-correlation method is used to study reactions that take place between Ho^{165}, Au^{197}, and U^{238} and various ions of 10.4 Mev/nucleon. For ions such as C^{12}, O^{16}, and Ne^{20} impinging on U^{238}, two peaks are observed in the correlation function. The larger and narrower one corresponds to a complete amalgamation of the ion with the target nucleus. For lighter targets, only this peak is observed. The vertical and horizontal spreads of this peak are correlated to neutron evaporation and to the fragment's mass and momentum spreads. The average number of neutrons emitted and their kinetic energy, 2T, are deduced from the experimental data. For all the system, 2T was found to be between 4.0 and 4.6 Mev. The method does not allow one to say if the neutrons are emitted from the fragments or the fissioning nucleus. For the system $He^4 + U^{238}$, the neutrons are found to be emitted isotropically to within 4%. In analyzing the second peak, it is found that the fis-

sioning nucleus has a momentum at an angle to the momentum of the ion. Values for the average momenta and angles of the fissioning nucleus and the stripped ion are obtained. The ion revolves with the nucleus for about 15 deg, during which approximately four nucleons are transferred. The cross section for these types of surface reactions is around 25% of the total fission cross section for C^{12}, 30% for O^{16}, and 40% for Ne^{20}. Surface reactions are also observed at lower bombarding energies. The stripped ion is emitted at increasing angles as the velocity of the ion decreases. This results in a relative increase in the forward momentum, that is approaching that of the heavy ion, thereby complicating analysis of the data. (auth)

25869 (UCRL-10805) A PRACTICAL GUIDE TO THE OPTIMUM UTILIZATION OF COOLING CAPACITY OF BOIL-OFF GAS FROM CRYOGENIC APPARATUS. William Chamberlain and Harvey Maseck (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 29, 1963. Contract W-7405-eng-48. 34p.

The loss rate of a liquid helium container was calculated by a method which includes the important effect of interception of heat conducted down the neck by boil-off gas flowing up the neck. The results indicated an optimum neck geometry for given flask design beyond which added neck length is not effective in reducing boil-off. A radiation shield is introduced between the liquid helium flask and the liquid nitrogen shield. This intermediate shield is thermally tied to, and cooled by, the flask neck. Its effectiveness in reducing loss rate is demonstrated. It is further shown that when the intermediate shield is employed, large increases in the emissivity of the liquid helium flask have a negligible effect on loss rate. A graph is presented which permits direct determination of loss rates with and without the intermediate shield for containers of known geometry and materials. The effect of instrument leads and supports either down the neck or through the vacuum can be included. (auth)

25870 (X62-11400) SPUTTERING EFFECTS ON THE MOON'S SURFACE. Report No. 2308. Quarterly Status Report No. 1, April 18–July 18, 1962. G. K. Wehner (General Mills, Inc., Minneapolis). July 18, 1962. Contract NASW-424. 23p.

Sputtering rates at the lunar surface to be expected from solar wind and storm bombardment are summarized in tabular form. For oxides the over-all rate is of the order of 1 Å/year. A Cu plate of 1 cm thickness would be sputtered away in 1.3×10^7 years. Accelerated sputtering experiments with targets made up of an assembly of small metal spheres and of metal dust layers show that sputtering has a tendency to level a macroscopically rough surface and to cement the particles into a crust. Similar experiments with oxide powders show that the oxides are converted under ion bombardment into metals or compounds richer in metal. (auth)

25871 (AEC-tr-5827) THE HALL EFFECT IN THE INHOMOGENEOUS MAGNETIC FIELD. Julius Brunner. Translated for Oak Ridge National Lab., Tenn. from Solid-State Electron., 1: 172-5(1960). 10p.

The Hall voltage of a long Hall generator in an inhomogeneous magnetic field, the normal component of which with respect to the Hall generator has a linear course in the longitudinal direction of the Hall generator, is calculated. For a gradient of the normal component that is extensively constant over the surface of the Hall generator, the error during the field measurement is calculated and it is found that it can be neglected in most cases occurring in practice. (auth)

25872 LASER-INDUCED THERMIONIC EMISSION. C. M. Verber and A. H. Adelman (Battelle Memorial Inst., Columbus, Ohio). Appl. Phys. Letters, 2: 220-2(June 1, 1963).

An experiment in which the electron emission signal resulting from the interaction of a ruby laser beam with thoriated W was found to be related to thermionic emission from W is described. Theoretical expressions relating the electron emission to the thermionic emission gave good agreement with experimental results. (D.C.W.)

25873 DEGRADATION FACTOR AND DIAMAGNETIC CURRENTS IN SUPERMAGNETS. B. S. Chandrasekhar (Westinghouse Electric Corp., Pittsburgh), W. F. Gauster, and J. K. Hulm. Appl. Phys. Letters, 2: 228-9(June 1, 1963).

The diamagnetic model proposed to explain the reduction of the critical current density when Nb–25% Zr wire is wound into a supermagnet is shown to be incorrect for an ideal solenoid and to disagree with experimental results. The validity of the model for Nb–Zr solenoids is therefore questionable. (D.C.W.)

25874 THE SOLUTION OF THE BOLTZMANN EQUATION FOR AN IMPACT WAVE WITH THE HELP OF THE BURNETT STATEMENT FOR THE DISTRIBUTION FUNCTION. W. Barthold (Universität, Kiel). Atomkernenergie, 8: 168-78(May 1963). (In German)

This work is a continuation of that begun in Atomkernenergie 8: No. 4, 1963. Integration of the differential equation, results, and conclusions are presented. (M.C.G.)

25875 INFLUENCE OF MATERIAL-DEPENDENT BACK-SCATTERING ON THE DOSE DISTRIBUTION OF A LARGE-AREA RADIATION SOURCE. Th. Tuchscheerer (Bundesforschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atomkernenergie, 8: 179-83(May 1963). (In German)

By experimental determination of the local dose values of a large-area x-ray anode, which depend on the material of the radiation cars transporting the material to be irradiated, it is shown how the back-scatter of the side walls of these cars can be employed for radiation field homogenization. Materials with extremely small back-scatter (lead), extremely large back-scatter (synthetic material Trovidur), and iron, as well as aluminum, are compared with one another. A usable proportion of the total intensity at the measuring site is reached only by the synthetic material back-scatter. The influence of the synthetic material back-scatter can become so large, at a sufficiently large anode distance, that the decrease in the radiation intensity from the center of the car towards the side of the car is almost compensated for. The consequence is that there is a constant incidental dose for the entire sample surface during irradiations with moving samples. This fact is a considerable simplification for practical dosimetry. (auth)

25876 APPLICATIONS: STANDARD SOLUTIONS OF VERY LOW VOLUME ACTIVITY. B. Grinberg, Y. Le Gallic, and M. Thénard. Bull. Inform. Sci. Tech. (Paris), No. 67, 58-62(Dec. 1962). (In French)

The preparation of standard solutions of very low volume activity encounters two principal difficulties: the determination of the volume activity of these solutions and the control of their radiochemical purity. The techniques used to avoid these difficulties are summarized. The results of an international comparison of a low-level $Sr^{90} + Y^{90}$ standard are reported. (J.S.R.)

25877 INTERMEDIARY TRANSFER OF EXCITATION IN XYLENE-BASED SCINTILLATORS. Milton Furst, Yves

Koechlin, and Alian Reviart (CENS, Saclay, France and New York Univ., New York). Compt. Rend., 256: 3639-42 (Apr. 22, 1963). (In French)

An intermediary process for nonradiative excitation transfer was shown in xylene-based scintillators. This transfer is due to the presence of an impurity, adsorbable on 4-Å molecular screen. It divides, by a factor greater than 10, the lifetime of the excited state of the xylene molecules, the reduction from 20 to 1.6 nsec. The time of transfer to the solute is evaluated at less than 2 nsec. (tr-auth)

25878 ON ENERGY TRANSFER BY GRAVITATIONAL WAVES. K. Kuchar and J. Langer (Charles Univ., Prague). Czech. J. Phys., 13: 233-42(1963). (In English)

The solutions of Møller's tetrad equations are found for the three types of exact gravitational waves, for which Møller's energy-momentum complex gives vanishing densities of gravitational energy and energy current. (auth)

25879 MEASUREMENTS ON VACUUM THERMO-ELECTRON GENERATOR. Masayoshi Ozawa, Toshikatsu Morita, and Kohei Ogasawara. Denki Shikensho Iho, 26: 752-8(1962). (In Japanese)

Experimental results obtained for the thermo-electron generator with W or Th–W electrodes, while heating the emitter and collector separately to 600 to 2400°C and keeping the inter-electrode distance between 0.03 and 0.1 mm, are presented. For a constant collector temperature, there is a certain emitter temperature at which its induced voltage is minimum and is even lower than that of the collector. An output current density of 0.3 amp/cm^2 at 1/v is obtained when the inter-electrode distance is 0.03 mm. With a W emitter, changing from a W to a Th–W collector increased the induced voltage 0.8v for the same conditions. The increase almost equals the difference in the work functions of the two materials. (auth)

25880 THEORETICAL ANALYSIS OF FINE FLUX MEASUREMENTS IN CONCENTRIC ANNULI FUEL ELEMENTS. G. B. Zorzoli (CISE, Milan). Energia Nucl. (Milan), 9: 635-9(Nov. 1962). (In English)

Fine flux measurements performed on the Aquilon II critical facility are reviewed to take into account the hardening of the thermal neutron spectrum and the actual epithermal neutron distribution. The derived results compare favorably with the experimental ones and exhibit a clear improvement with respect to the previous calculations. (auth)

25881 MEASUREMENT OF THE WORK PER ION PAIR IN NITROGEN FOR PROTONS AND He IONS IN THE ENERGY REGION BELOW 1 Mev. L. Schaller, P. Huber, and E. Baumgartner (Universität, Basel). Helv. Phys. Acta, 36: 113-31(1963). (In German)

The average energy loss W per ion pair for protons and He ions in N_2 was determined as a function of the energy of the incident ions. The energy loss W was obtained by measuring both the current and the energy of the accelerated particles and the current of ions produced in an ionization chamber. No variation of W was found within the limits of error for protons in the energy range 200 to 900 kev. The mean value $\overline{W}_p = 37.0 \pm 0.8$ ev per ion pair is in agreement with measurements by other authors in neighboring energy ranges. In the energy interval 270 to 630 kev also no variation of W_{He} was found, but the value was significantly greater than the Po α-value. The difference is thought to be caused partly by charge-exchange processes and partly by the increasing importance of nuclear collisions. (auth)

25882 INTERPENETRATION OF TWO IONIZED GAS CLOUDS. [PART] II. V. B. Bhatia (S. D. Coll., New Delhi, India) and J. N. Tandon. Indian J. Phys., 37: 54-7(Jan. 1963).

Counterstreaming of two ionized gas clouds is considered by taking account of the gas pressures of the two clouds. It is shown that the counterstreaming is in general, unstable. (auth)

25883 THE RELATIONSHIP BETWEEN ATOMIC RADII IN CLOSE-PACKED AND BODY-CENTERED CUBIC STRUCTURES. Jerry Donohue (Univ. of Southern California, Los Angeles). J. Am. Chem. Soc., 85: 1238-40(May 5, 1963).

Data on transitions between the body-centered cubic structure and either the cubic or hexagonal close-packed structure for sixteen elements were examined, and it is found that the equation $R(1) - R(n) = 0.300 \log n$ does not satisfactorily account for the observed interatomic distances. On the other hand, the ratios R(12)/R(8) between the atomic radii in the two structures all lie quite close to the value of 1.029 expected if the volume change on transition is zero. (auth)

25884 SUPPRESSION OF THE DISCHARGE IN IODINE VAPOUR DUE TO RADIO-IODINE(^{131}I). H. J. Arnikar and M. G. Nene (Banaras Univ., India). J. Electron. Control (1), 14: 389-92(Apr. 1963). (In English)

The addition of radio-iodine (I^{131}) to iodine vapor under discharge (0.5 mC/g) leads to a current suppression of 30 to 60% under a-c and nearly 100% under d-c excitation. With the decay of radio-iodine, the suppression diminishes progressively. Results are explained on the basis of increased 'dead time' of the system due to the cropping up of positive ions (formed by radiations from I^{131}) throughout the gas phase. Their accumulation suppresses the discharge, which may be considered as the analogue of Joshi effect due to internal irradiation. (auth)

25885 A THEORETICAL STUDY OF THE EFFECT OF P-LAYER RESISTANCE ON THE EFFICIENCY OF PHOTOVOLTAIC SOLAR ENERGY CONVERTERS. A. U. Momin and A. P. B. Sinha (National Chemical Lab., Poona, India). J. Electron. Control (1), 14: 425-36 (Apr. 1963). (In English)

A theoretical investigation was made to determine the exact role which the internal series resistance and the surface layer (p or n layer) resistance play in determining the conversion efficiency in solar energy converters using p-n junction photovoltaic cells. An equivalent circuit of the photovoltaic solar cell which is represented by a network consisting of a large number of current sources interconnected through series resistors, simulating the effect of sheet resistance of the surface layer, is assumed. Two models of photovoltaic cells were analyzed; in one, only the sheet resistance was considered, neglecting the internal resistance (Case I), and in the other, some internal resistance was also assumed (Case II). The differential equations in the above analysis were solved making certain approximations, which are shown to be quite valid. Graphs showing the relationships between the power developed and the various parameters are given. (auth)

25886 LARGE-SCALE IRREGULARITIES IN THE IONOSPHERE. J. E. Titheridge (Univ. of Auckland, N. Z.). J. Geophys. Res., 68: 3399-3417(June 1, 1963).

The amplitude of the 20-Mc signal from the satellite Explorer 7 is recorded at Auckland from November 1960 to August 1961. Variations in the fading period are used to study the irregularities that occur in the electron density

of the ionosphere. Relations are given for calculating the size and density of these irregularities directly from plots of the fading period of the received signal. Results for 770 irregularities, observed at all times of day, with sizes from 5 to 500 km, are presented. The number with sizes between S and S + ΔS is approximately proportional to ΔS/S. The electron content of the irregularities, measured vertically is generally between 0.03 and 4% of the total electron content of the ionosphere, with a median value of 0.25%. The density at the center of the irregularities differs from the density of the background ionization by about 1% for the smaller and 10% for the largest ones. The irregularities are not elongated in the direction of the magnetic field, but occur in the form of horizontal slabs with a vertical thickness equal to about one-fifth of the horizontal dimension. The fact that most irregularities larger than 50 km occur in series of three or more similar ones suggests that they are caused by a wave of disturbance propagated through the ionosphere with a wavelength of about 100 km. (auth)

25887 THE INFRARED SPECTRUM OF METHYL-d_3 CYANIDE. William H. Fletcher and Charles S. Shoup (Univ. of Tennessee, Knoxville). J. Mol. Spectry., 10: 300-8(Apr. 1963).

Four perpendicular bands in the spectrum of CD_3CN were resolved and analyzed. A reassignment of some of the overtones was made in the light of a more detailed recording of the spectrum. Rotational constants and Coriolis coupling coefficients are in agreement with those expected for the isotopic species. (auth)

25888 FLUORINE NMR SPECTROSCOPY—STUDIES OF ^{13}C SATELLITE SPECTRA. Robin K. Harris (Mellon Inst., Pittsburgh). J. Mol. Spectry., 10: 309-19(Apr. 1963).

Values are presented of (F,F) and (^{13}C,F) coupling constants and of isotopic chemical shifts, obtained from the study of C^{13} satellites in F^{19} NMR spectra. Correlations are suggested of these values with the nature of substituents directly attached to the C^{13} atom, in particular its place in the Periodic Table. Some theoretical hypotheses relating to the nuclear magnetic parameters are qualitatively discussed. (auth)

25889 APPLICABILITY OF RAYLEIGH—GANS SCATTERING TO SPHERICAL PARTICLES. M. Kerker, W. A. Farone, and E. Matijevic (Clarkson Coll. of Tech., Potsdam, N. Y.). J. Opt. Soc. Am., 53: 758-9(June 1963). (TID-17684)

Exact computations of scattering functions for spheres are compared with those obtained from the Rayleigh–Gans theory of scattering of electromagnetic radiation. The range of validity for spheres as a guide for non-homogeneous particles and other geometries. This study is limited to nonabsorbing particles with real indices of refraction. (C.E.S.)

25890 DOUBLE FREQUENCY SCATTERING. Lajos Jánossy and Miklós Huszár. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 77-87(1963). (In Hungarian)

A hydrogen atom exposed to electromagnetic radiation of frequency ω emits waves of frequencies ω, 2ω, ... With the aid of the hydrodynamical model of quantum mechanics the intensity of the waves of frequency 2ω was determined. It was found that the intensity of double frequency was too low to be observed experimentally. (auth)

25891 EFFECT OF THE NON-LINEAR RESPONSE OF NaI(Tl) ON THE SINGLE CRYSTAL SUMMING SPECTRA. H. G. Devare and P. N. Tandon (Tata Inst. of Fundamental Research, Bombay). Nucl. Instr. Methods, 22: 253-5(Apr. 1963). (In English)

The summing spectra of the two gamma and three gamma cascades in Lu^{177}, Co^{60}, Y^{88}, Na^{24}, Na^{22}, and Pm^{144} were investigated with a 3 in. × 3 in. well type NaI(Tl) crystal. The sum peaks appear to shift to higher energy region because of the non-linear response of the NaI(Tl) crystal. The energy corresponding to the sum peak position was determined from a linear least square fit of the calibration points and the shift was determined in each case. The light output per kev was determined for a number of gamma rays of accurately known energy and was plotted as a function of the gamma-ray energy. The observed shifts are compared with the values expected on the basis of this light output per kev curve. (auth)

25892 A SCATTERING CHAMBER USING JUNCTION COUNTERS. E. J. Feldl, J. R. Meriwether, G. R. Choppin, and J. D. Fox (Florida State Univ., Tallahassee). Nucl. Instr. Methods, 22: 333-8(Apr. 1963). (In English)

The specifications and characteristics of a versatile scattering chamber are presented. The chamber is designed for use with solid state detectors. It became necessary in the course of a study of the fission of U^{238} and Th^{232} by a proton beam from the Florida State University Tandem Van de Graaff to design a small scattering chamber in which solid state junction counters could be positioned precisely at various angles around the target. The following features were desirable in the scattering chamber: (a) precise positioning of the target; (b) precise positioning of counters both with respect to the distance from the target and the angle to the beam; (c) ease of rotation of the counters to different angles; (d) provision for both movable and fixed counters; (e) precise positioning of the chamber about the beam tube; (f) precise defining slits for both the beam and the particles to be counted; (g) freedom from trailing lead wires as the counters are rotated; (h) a Faraday cup which provided accurate measurements of the beam current. The chamber which was designed possesses all of these features. (auth)

25893 A MONTE-CARLO TECHNIQUE FOR INVESTIGATIONS OF THE FOCUSING PROPERTIES OF LONG MAGNETIC LENSES. I. Lindgren, B. Olsen, G. Pettersson, and W. Schneider (Uppsala Univ.). Nucl. Instr. Methods, 22: 358-60(Apr. 1963). (In English)

A new method was developed which involves the simulation of a specific beta-ray spectrometer on a computer and the calculation of the number of electron trajectories passing through the baffle system of the spectrometer. The method was applied to a triangular field form with an envelope baffle system and results are given. (D.L.C.)

25894 A HOODED ARC CYCLOTRON ION SOURCE WITH VARIABLE YIELD. W. L. Rautenbach and K. Lubbinge (National Physical Research Lab., Pretoria). Nucl. Instr. Methods, 22: 367-8(Apr. 1963). (In English)

The first hooded arc ion source constructed for the Pretoria cyclotron was found to be unstable, with most of the ionizing collisions by primary electrons occurring near the filament and in the collimating hole. In order to obtain a uniform gas pressure distribution throughout the discharge column, two additional ion sources were designed, one with a subsidiary channel feeding gas to the top of the chimney and the other with a very small outlet. It was found that, for both sources, the yield could be varied easily by altering the discharge conditions. (D.L.C.)

25895 DETERMINATIONS OF THE TOTAL EMISSIVITY OF POLISHED AND OXIDIZED URANIUM SURFACES. L. Baker, Jr., E. M. Mouradian, and J. D. Bingle (Argonne National Lab., Ill.). Nucl. Sci. Eng., 15: 218-20(Feb. 1963).

In order to be able to estimate heat losses due to radiation, total emissivity measurements were carried out on U

cubes heated to <1133°C and then cooled in vacuum. The average ϵ values were: for polished U, 0.37, 0.36, and 0.33 for the γ, β, and α phases; for oxidized U (~700 μg O_2/cm^2), 0.61, 0.61, and 0.58 for γ, β, and α phases; and for oxidized U (~1000 μg O_2/cm^2), 0.73, 0.71, and 0.68 for γ, β, and α phases. (D.L.C.)

25896 SOME NUCLEAR-CHEMICAL AND PHYSICO-CHEMICAL PROBLEMS IN FISSION-PRODUCT RECOIL SEPARATION. Ury Passy and Naftali H. Steiger (Israel Inst. of Tech., Haifa). Nucl. Sci. Eng., 15: 366-74(Apr. 1963).

Most of the energy generated during the fission process is released as kinetic energy of the fission products. This energy moves the fission products a distance of a few microns in solid materials. When the fissionable material is prepared as a powder of particles with diameters smaller than the range of the fission products in the material used, it is expected that the fission products will leave the particles of the fissionable material. To avoid the penetration of the fission product into an adjacent particle of fissionable matter, the latter may be diluted with a liquid or solid diluent. The use of solid diluents having strong adsorption properties is believed to improve the separation between fission products and fuel when sedimentation in water is chosen as the separation method. In a series of experiments, mixtures of U_3O_8 with infusorial earth and silica gel as diluents having strong adsorbing properties were irradiated. About 95% of the fission products were found in the diluent. Most of the activity of the U_3O_8 was due to Np. The readsorption of fission products to U_3O_8 was smaller than in previous experiments in which no adsorbent was mixed with the fissionable material. Surface activation of the U_3O_8 was found after irradiation. About half of the fission products taken up by the diluent were found to be absorbed at its surface. Mean fission-product ranges in U_3O_8 were estimated on an experimental and theoretical basis and agreement between theory and experiment is found to be good for most of the fission products. (auth)

25897 SOLUTION TO THE FISSION RECOIL ENERGY DEPOSITION IN A SLURRY BY A MONTE CARLO TECHNIQUE. Lawrence R. Steele (Argonne National Lab., Ill.), Daniel Carson, and Charles E. Dryden. Nucl. Sci. Eng., 15: 451-7(Apr. 1963). (TID-16935; UAC-6644)

A Monte Carlo technique was developed for predicting the mode of energy transfer from fission fragments liberated within spherical solids to the fluid or neighboring particles in a slurry. Random location energy liberation for a large number of fissions within the solids and subsequent absorption was followed by means of a high-speed digital computer program. The fraction of recoil fragments and energy spectrum deposited in the fluid was characterized as a function of concentration and particle size of the solids. From these results, a useful correlation equation was developed. (auth)

25898 ON A BORN APPROXIMATION FOR ELECTRON-HYDROGEN SCATTERING. E. Corinaldesi and H. E. Lin (Iowa State Univ., Iowa City). Nuovo Cimento (10), 28: 651-3(May 1, 1963). (In English)

The transition amplitudes for electron-hydrogen scattering in the singlet and triplet spin state of the electrons are presented in the first Born approximation obtained by perturbation methods. The total cross section as a function of incident electron energy and the differential cross section for scattering of 9.4, 7.1, and 5.7 ev electrons in the conventional first Born approximation are given. The results are compared with experiment. (C.E.S.)

25899 OUTLINE OF A PERTURBATION THEORY OF THE HYDROGEN MOLECULE. [PART] II. E. Corinaldesi and H. E. Lin (Iowa State Univ., Iowa City). Nuovo Cimento (10), 28: 654-7(May 1, 1963). (In English)

By a standard perturbation method employing a complete set of unperturbed wavefunctions, the energy shift arising from the perturbation of the hydrogen molecule is obtained. Solutions of the modified Shroedinger equations are constructed from solutions of the ordinary Shroedinger equation. (C.E.S.)

25900 A NOTE ON LOCAL COMMUTATIVITY. [PART] II. Y. Tomozawa (Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuovo Cimento (10), 28: 667-70(May 1, 1963). (In English)

The proof of three lemmas pertaining to the proof of a theorem on local commutativity in quantum field theory is presented. (C.E.S.)

25901 RELATIVISTIC RIGID-BODY TRANSLATIONS. A. A. Evett (Univ. of Arizona, Tucson). Nuovo Cimento (10), 28: 685-94(May 16, 1963). (In English)

Two derivations of defining equations for relativistic rigid-body translations are presented, both of which yield the same defining equation. One derivation is based on setting up an idealized dynamical model of a relativistic rigid body, while the second derivation is based only on covariance and simplicity postulates. The definition obtained is different from the Born conditions of rigidity. (auth)

25902 EXAMPLES OF RELATIVISTIC RIGID-BODY TRANSLATIONS. A. A. Evett (Univ. of Arizona, Tucson). Nuovo Cimento (10), 28: 706-11(May 16, 1963). (In English)

The defining equations for relativistic rigid-body translations are solved for a number of situations. (auth)

25903 A GEOMETRIZED CLASS OF YANG-MILLS FIELDS. G. R. Allcock (Univ. of Liverpool, Eng.). Nuovo Cimento (10), 28: 858-64(May 16, 1963). (In English)

The geometrization of the electromagnetic field is considered in the discussion of the mathematical properties of a class of non-trivial Yang-Mills fields, derived geometrically from a velocity field. (C.E.S.)

25904 POLYNOMIAL EXPANSION OF GRAVITATIONAL LAGRANGIAN. A. Peres (Israel Inst. of Tech., Haifa). Nuovo Cimento (10), 28: 865-7(May 16, 1963). (In English)

It is shown that by a suitable choice of dynamic variables, the gravitational lagrangian and all the interesting lagrangians can be written as polynomials rather than as infinite series. (C.E.S.)

25905 CALCULATION OF POTENTIAL FIELDS AND ELECTRON TRAJECTORIES USING AN ELECTRONIC COMPUTER. C. Weber. Philips Tech. Rev., 24: 130-43 (1962-63). (In English)

An important problem in electron optics is to determine how the electrons move in the space between given electrodes with given potentials. The numerical method of solving the problem is described. An advantage of the method is that it is also applicable to cases involving space charge. Owing to the considerable computation entailed, an electronic computer is indispensable. Among the subjects discussed are the derivation of a difference equation for the potential field and one for the electron trajectories, the iterative method, and the method of successive over-relaxation to accelerate convergence. It is explained how the potential fields and trajectories are computed using an IBM 650 machine. Two examples are given by way of illustration. (auth)

25906 A STUDY OF ROTATIONAL FREEDOM IN SEVERAL AMMONIUM SALTS BY SLOW NEUTRON INELASTIC SCATTERING. V. Brajovic, H. Boutin, G. J. Safford, and H. Palevsky (Brookhaven National Lab., Upton, N. Y.). Phys. Chem. Solids, 24: 617-24(May 1963). (In English) (BNL-6488)

Differential inelastic cross sections for 0.005 ev incident neutrons scattered at 90° from polycrystalline samples of NH_4PF_6, $NH_4K_xI_{1+x}$, $(NH_4)_2S_2O_8$, and NH_4SO_3F were studied. Measurements were made at T = 294°K for all four samples, at T = 103°K for NH_4PF_6, and at T = 348°K for $(NH_4)_2S_2O_8$. The observed shapes of the energy spectra for neutrons gaining energy are compared at each temperature with shapes calculated on the basis of a Kreiger–Nelkin approximation, assuming free three-dimensional rotation of the NH_4^+ ions. The results show that the energy spectra of neutrons scattered from NH_4PF_6 and $NH_4K_xI_{1+x}$ at T = 294°K (kT ~ 0.6 kcal/mole) approach the expected shape for free rotations of the ammonium ion with effective masses of 2.8 and 2.0, respectively. The neutron spectra from NH_4SO_3F and $(NH_4)_2S_2O_8$ at T = 294°K (kT ~ 0.6 kcal/mole) have nearly the same shape and show a considerable departure from the shape expected for free rotation, but at T = 348°K (kT ~ 0.7 kcal/mole) the neutron-energy-gain spectrum from $(NH_4)_2S_2O_8$ closely approaches the shape expected for free rotation with an effective mass of 2.0 mass units. At T = 103°K (kT ~ 0.2 kcal/mole) the neutron spectrum from NH_4PF_6 departs in shape significantly from the shape expected for free rotation. These results are consistent with previous rough estimates of rotational barriers of 0.2 kcal/mole for NH_4PF_6 and 0.7 kcal/mole for $(NH_4)_2S_2O_8$ and NH_4SO_3F. (auth)

25907 CALCULATED SPECIFIC HEAT CONTRIBUTION OF F_2^- CENTERS IN LiF. W. C. Obermoeller and W. A. Barker (St. Louis Univ.). Phys. Chem. Solids, 24: 641-8(May 1963). (In English)

The Schottky heat capacity of F_2^- centers in LiF was computed using the molecular ion model, the spin Hamiltonian, and the associated eigenvalue equation in terms of which spin resonance and optical absorption data have been so adequately interpreted. An anisotropic hyperfine peak occurs at $T_{P_1} \approx g_0\beta_0 b \cos\theta/3.72k \approx 10^{-2}$°K where b is a hyperfine constant and θ is the angle between the molecular bond axis and the magnetic field. An isotropic "hole" spin Zeeman peak occurs at $T_{P_2} \approx g_0\beta_0 H/2.4k \approx 10^{-1}$°K for H between 1 and 10 kg. For 10^{18}/cm^3 centers, the hyperfine heat capacity maximum is ~100 erg/°K cm^3 and the "hole" heat capacity maximum is ~65 erg/°K cm^3. If the related experiment were performed, these contributions would greatly exceed the lattice heat capacity for T ≤ 1°K, but would probably be partially disguised by other paramagnetic contributions. (auth)

25908 ORIGIN OF F-CENTERS IN X-RAY IRRADIATED NaCl CRYSTALS. M. Geudeki and W. G. Burgers (Technische Hogeschool, Delft, Netherlands). Phys. Chem. Solids, 24: 667-9(May 1963). (In English)

Etching of NaCl crystals x-ray irradiated at room temperature does not reveal a displacement of dislocation lines such as might be expected according to various mechanisms suggested in the literature for the generation of F-centers at dislocations. (auth)

25909 SOME EFFECTS OF A PERTURBATION IN A LATTICE ON THE NORMAL MODES. T. N. Casselman and Jordan J. Markham (Illinois Inst. of Tech., Chicago). Phys. Chem. Solids, 24: 669-79(May 1963). (In English)

A one-dimensional, monatomic chain with an isotopic defect at the center was considered. The effect of the defect on the crystalline modes was calculated. It is shown that small changes in the frequencies of the crystalline modes make the most important contributions to the ion displacements near the defect. It is shown that the broadening of the absorption line can be calculated independently of the knowledge of the normal modes as long as an effective frequency approximation can be made. As an illustration of the effect of the defect on the crystalline modes, the broadening for several isotopic defects was calculated. The several bands of modes which contribute to the broadening are shown and it is pointed out how the position of these bands on the spectrum is strongly dependent on the mass of the defect. (auth)

25910 ONE-DIMENSIONAL PHASE TRANSITION IN THE SPHERICAL MODEL OF A GAS. H. A. Gersch (Georgia Inst. of Tech., Atlanta). Phys. Fluids, 6: 599-608(May 1963).

Thermodynamic properties and molecular pair distribution functions are calculated for the one-dimensional spherical model of a gas with an attractive interaction outside of a hard core, in the limit as the range of attractive forces becomes infinite. In this limit, a phase transition appears, and the equation of state consists of analytically different parts. The calculations are made using the canonical ensemble which permits a description of the two-phase region. Properties in this region are found to have a simple description in terms of the co-existence of gas and liquid phases. (auth)

25911 PARTITION FUNCTION FOR A GENERALIZED TONKS' GAS. Donald Koppel (Columbia Univ., Dobbs Ferry, N. Y.). Phys. Fluids, 6: 609-16(May 1963).

The partition function of a system of N identical rigid rods connected by identical springs is reduced to a one-fold integration. This integration is explicitly performed in the limit $N \to \infty$ by the method of steepest descent. The system behaves respectively as a gas and as a solid in two different limiting cases. The calculated isotherms and specific heat show that the transition between these limiting cases is continuous. (auth)

25912 GROWTH OF A WEAK MAGNETIC FIELD IN A TURBULENT CONDUCTING FLUID WITH LARGE MAGNETIC PRANDTL NUMBER. Yih-Ho Pao (Johns Hopkins Univ., Baltimore). Phys. Fluids, 6: 632-6(May 1963).

The behavior of a weak fluctuating magnetic field in a turbulent electrically conducting fluid with large magnetic Prandtl number is re-examined, without using vorticity analogy. For large magnetic Prandtl number, the characteristic length of the small eddies of turbulence is much larger than that of the small loops of the magnetic field. By inferring that the small eddies of turbulence are mainly responsible for the change of the fluctuation intensity of the magnetic field and by utilizing Batchelor's mixing approach, visualizing the turbulent velocity field as effectively a rather persistent uniform straining motion for the small-scale variation of magnetic field, it was found that the fluctuation intensity of the magnetic field grows due to turbulent motion for very large magnetic Prandtl number [$(\nu/\lambda) > 100$, say] and approaches a constant value asymptotically. The rate of growth is found to be a function of ν/λ and τ (the product of time and the turbulent straining rate). (auth)

25913 JOINT INSTABILITY OF HYDROMAGNETIC FIELDS WHICH ARE SEPARATELY STABLE. Melvin E. Stern (Woods Hole Oceanographic Institution, Mass.). Phys. Fluids, 6: 636-42(May 1963).

It is found that certain parallel magnetic fields can destabilize the plane Couette flow of a perfectly conducting fluid, though this flow is known to be stable when there is no field. The destabilizing role of the rigidity of the field is attributed to its ability to prevent the stretching of curves of constant perturbation vorticity by the shear. Unstable long waves transfer energy to the mean magnetic field from the kinetic field by means of the Reynolds stresses. This suggests the possibility of maintaining an electrical current that is initially introduced between two differentially rotating cylinders. (auth)

25914 HYDROMAGNETIC FREE JET. Richard L. Peskin (Rutgers Univ., New Brunswick, N. J.). Phys. Fluids, 6: 643-7(May 1963).

Laminar and turbulent two-dimensional incompressible viscous free jet flow is studied for a conducting fluid. A constant magnetic field transverse to the axis of the jet is considered and the stream functions are expanded about the nonmagnetic jet solutions. The parameter of expansion is the square of the Hartmann number divided by the Reynolds number and results are computed to the first order in the expansion parameter. The results indicate a qualitative similarity for both the laminar and turbulent cases. The magnetic field depresses the axial velocity of the jet near the center of the jet but increases the axial velocity in the outer regions of the jet. The transverse velocity at the jet boundary is reduced in the presence of the magnetic field. The discharge rate of the jet is also reduced in the presence of magnetic field. (auth)

25915 INVESTIGATION OF THE CHAPMAN-JOUGUET HYPOTHESIS BY THE INVERSE METHOD. W. W. Wood and Wildon Fickett (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 6: 648-52(May 1963). (LADC-5552)

Generalizing a particular case studied by Jones, Stanyukovich, and Manson have given general equations connecting the Chapman–Jouguet detonation pressure; the derivative $\alpha = p(\partial v/\partial E)_p$ of the equation of state E(p,v) of the product gases; the derivatives of the detonation velocity D with respect to the thermodynamic variables defining the initial state of the explosive, such as the initial density ρ_0; the variables D and ρ_0 themselves and after a careful derivation of this result, it is pointed out that in conjunction with experimental observations of the unsupported detonation-wave pressure p and velocity D and the derivatives of D with respect to two independent initial variables (e.g., ρ_0 and E_0), it permits an experimental test of the basic assumptions of detonation theory, namely the assumption of laminar flow and the Chapman–Jouguet hypothesis. Several experimental possibilities are suggested for condensed explosives, where direct experimental observations (such as White's interferometric detection of apparent turbulent flow in gaseous detonations) are difficult. An erroneous criticism, by Pujol and Manson, of Jones' relation as applied to the density dependence of the detonation velocity in low-density solid explosives is also corrected. (auth)

25916 ELECTRIC ARC-DRIVEN SHOCK TUBE. John C. Camm and Peter H. Rose (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 6: 663-78(May 1963).

A shock tube capable of producing a gas sample of known conditions by shocks with velocities as high as 43,000 ft/sec was developed. The driver of this shock tube employs a capacitor bank that discharges electrical energy into helium, heating the helium to temperatures of 10,000–20,000°K, and raising the pressure to 10,000–20,000 psi. The high-pressure bursts the scribed diaphragm, and the resulting shock wave propagates into the test gas. Diagnostic techniques were employed to investigate the resulting hot gas sample. The growth of this sample was observed optically, and correlations were achieved with theoretical calculations. The observed radiation was compared with and can be used to extend the known radiative properties of high temperature air. Time-resolved luminous pictures and spectra were also taken to show the purity of the test gas. The speed and attenuation of the shock front were measured. The observed operation of this shock tube was compared with theoretical predictions, and although no precise correlation can be made, the driver gas energy transfer and losses in the shock tube boundary layer can be accounted for. (auth)

25917 INTERPRETATION OF LUMINOUS PHENOMENA OBSERVED IN ELECTROMAGNETIC SHOCK TUBES. M. Cloupeau (Institut du Radium, Paris). Phys. Fluids, 6: 679-88(May 1963).

A series of experiments with electromagnetically driven shock waves in various gases showed that the luminous emission observed along the tube should often be interpreted as being due to direct ionization produced by the driver discharge and not to thermal ionization produced by the shock wave. The experiments also show that for high Mach numbers obtained at low initial pressures (of the order of 1 mm Hg), the shock front and the front of the discharge plasma jet (contact front) practically coincide. Thus, in contradiction with the conclusions reached by Kolb, Griem, and others, the state of the luminous gas following the shock front cannot be calculated by the Rankine–Hugoniot equations from the velocity of the front. The results presented were obtained by spectrographic investigation of the light emitted along a special H-shaped glass tube in which the gas between one of the electrode pairs is initially different from that filling the rest of the tube. (auth)

25918 SHOCK INTERACTION WITH AN ELECTROMAGNETIC FIELD. J. Rosciszewski and A. K. Oppenheim (Univ. of California, Berkeley). Phys. Fluids, 6: 689-98 (May 1963).

The interaction between a traveling shock wave and a stationary magnetic field is analyzed for the simplest case of one-dimensional flow across a rectangular system of a magnetic and an electric field, while the flowing substance is a plasma of finite conductivity but associated with a sufficiently small magnetic Reynolds number to render the induced magnetic effects negligible. The acceleration of the shock wave produced by a constant electric field applied across the duct walls in the presence of a perpendicular magnetic field, as well as its attenuation due to a distributed system of outside resistances connecting a series of electrodes on the sidewalls of the duct, were calculated by quadratures. The flow field behind the wave was determined by means of a perturbation technique whose validity is restricted to cases of small Lorentz forces and moderate Joule heating effects. To gain more familiarity with the interaction process a hydraulic analog is proposed, based on the use of a piston driven, free surface, mercury channel. In this connection, a general solution is consequently obtained for the interaction of a hydraulic jump traveling in a conducting liquid with a vertical magnetic field in the presence of a horizontal electric field. (auth)

25919 A FEATURE OF PRECURSOR IONIZATION PROFILES DUE TO SHOCK RADIATION. Lewis Wetzel (Brown Univ., Providence). Phys. Fluids, 6: 750-2(May 1963).

An expression is derived for the electron density pro-

duced by ionization ahead of shock fronts in air, and the marked effect of the absorption cross section dependence on radiation frequency is illustrated for falling cross sections. (auth)

25920 AXIAL COMPONENT OF MUTUAL FRICTION IN UNIFORMLY ROTATING LIQUID HELIUM. H. A. Snyder (Univ. of Chicago). Phys. Fluids, 6: 755-64(June 1963).

For helium II in uniform rotation, the component of mutual friction along the rotational axis B_z was studied. The attenuation of second sound transverse to the axis of rotation was compared with the attenuation in the direction of the axis. It is shown: that $B/B_z > 500$ over a large range of temperature and frequency; that B_z is not very reproducible; that B_z is dependent on the second sound amplitude; and that B_z is not linear in Ω, the rate of rotation. The data on B agree with the results of Hall and Vinen within the temperature and frequency range covered. Near the λ point, B increases rapidly. The anomalous dependence of B on Ω near 2.0°K as reported by Hall and Vinen is not observed. Some preliminary measurements of the parameter B′ are mentioned. (auth)

25921 THERMODYNAMICS OF He^3 AND He^4 SOLUTIONS ABOVE THE λ-TEMPERATURE OF PURE He^4. R. Chandra and V. S. Nanda (Univ. of Delhi). Phys. Fluids, 6: 765-71(June 1963).

The thermodynamic properties of He^3 and He^4 solutions in the temperature range 2.2 to 2.6°K were investigated on the basis of some of the classical theories of nonideal solutions. Calculations were also made of the excess chemical potentials from the vapor pressure data using some general thermodynamical considerations. These results are then compared with those obtained from the theories considered. (auth)

25922 IONIZED GASES AT LOW DENSITY IN AXIALLY SYMMETRIC MAGNETIC FIELDS. Louis R. Henrich (RAND Corp., Santa Monica, Calif.). Phys. Fluids, 6: 824-7(June 1963).

The Boltzmann equation is used to derive the expression for the current in ionized gases at low density in an axially symmetric nonuniform field. The gas is assumed to be in a steady state and collisionless. Using this method, the usual expression for the total drift current is obtained without the necessity of using first-order orbit theory. When the integration is made over the whole region of charged particles, the diamagnetic terms clearly do not contribute to the total current. (auth)

25923 MAGNETIC DOMAINS IN GADOLINIUM. R. R. Birss and P. M. Wallis (Imperial Coll. of Science and Tech., London). Phys. Letters, 4: 313(May 15, 1963). (In English)

The bitter patterns of ferromagnetic domains on a $(11\bar{2}0)$ crystallographic plane of a gadolinium single crystal are presented. A suspension of magnetite particles in xylene, stabilized with a ten millimolar concentration of sodium di(ethylhexyl) sulfosuccinate was employed at −5°C. On the application of a magnetic field, the walls separating adjacent domains were observed to move in the customary manner, the movement being similar to that obtained with cobalt and other uniaxial ferromagnetic materials. (C.E.S.)

25924 ON THE POSSIBILITY OF ANOMALOUS FLUCTUATIONS IN LIQUID HELIUM II. I. A. Akhiezer (Physico-Technical Inst., Kharkov). Phys. Letters, 4: 316-17(May 15, 1963). (In English)

It is shown that a situation exists in which fluctuations of various physical quantities are anomalously large in liquid helium II through which a stream of ions is passing. The scattering cross sections for light and for slow neutrons are found to be anomalously large. This phenomenon is analogous to the anomalous magnitude of fluctuations in a plasma with electrons drifting versus ions. (C.E.S.)

25925 A NOTE ON THE MAGNETOSTRICTION OF HOLMIUM. E. W. Lee (The University, Sheffield, Eng.). Phys. Letetrs, 4: 358-9(May 15, 1963). (In English)

It is reported that the small lattice strains observed in magnetostriction measurements of holmium are the result of measuring at a temperature for which holmium is antiferromagnetic and at which the critical field is larger than the fields employed. (C.E.S.)

25926 SECONDARY ELECTRON EMISSION PRODUCED BY RELATIVISTIC PRIMARY ELECTRONS. Arvid A. Schultz and Martin A. Pomerantz (Franklin Inst., Swarthmore, Penna.). Phys. Rev., 130: 2135-41(June 15, 1963).

Investigations of the primary energy dependence of the rate of production of secondary electrons by relativistic primary electrons, and of the nature of the secondary energy distributions, were conducted. The sandwich arrangement, characterized by the feature that the primary beam is essentially monoenergetic while traversing the target, was utilized. Spectra of electrons emitted from C, Ni, and Al bombarded by primaries having energies over the range 0.3−1.6 Mev were determined. The distributions were essentially identical with those previously measured at much lower energies. The secondary electron yield was determined as a function of primary energy for C, Ni, and Al. With thick targets, and at lower energies, an enhancement occurs as a consequence of elastic scattering. The application of calculated corrections for this effect provides yield values that, for a given material, are independent of target thickness. The result that the data then follow the theoretical energy-loss curves indicates that the yield is proportional to dE/dx. Earlier measurements of the variation of yield with primary angle of incidence were extended to lower primary energies. An apparent saturation of the yield at steep angles of incidence occurs as a consequence of a balance between the enhanced production rate and the loss of primaries that are scattered out of the surface. It is concluded from the various results of these experiments that the secondary emission process can be represented by the relationship: $\delta = \epsilon^{-1}(dE/dx)\Delta x \sec\theta$, where δ is the number of emitted secondary electrons per incident primary, ϵ is the average energy required to produce one emergent secondary electron, dE/dx is the rate of energy loss of the primary electrons, Δx is the thickness of the region in which escaping secondary electrons are produced, and θ is the angle of incidence of the primary electrons. Values of the ratio $\epsilon/\Delta x$ = 150 kev cm^2/mg for C, 90 kev cm^2/mg for Al, and 100 kev cm^2/mg for Ni, are in agreement with those previously determined with 1−10 kev primaries. For bulk Al targets, the ratio of the measured yield at 1 kev to that at 1 Mev, approximately 55, is equal to the corresponding ratio of the theoretical rates of energy loss. (auth)

25927 SIZE FACTOR AND SUPERCONDUCTING PROPERTIES OF SOME TRANSITION METAL SOLUTIONS. Warren DeSorbo (General Electric Co., Schenectady, N. Y.). Phys. Rev., 130: 2177-87(June 15, 1963).

Superconducting primary substitutional solid solutions, consisting of niobium, vanadium or tantalum (column V of the periodic table) alloyed with a metal of column IVA or VIA, show interesting correlations between size of solute and (a) lattice parameter, (b) critical temperature, (c) critical current, (d) coefficient of electronic specific heat,

and (e) the Debye characteristic temperature. Solute atoms larger than the matrix atoms increase (a), (b), (c), and (d), but decrease (e). Solute atoms smaller in size decrease (a), (b), (c), and (d), but increase (e). T_c is found to correlate better with an effective e/α ratio, that contains a size-dependent correction than with the usual e/α ratio. Magnetization studies indicate that these alloys approach an Abrikosov type of behavior when the sample is in powder form. In bulk form hysteresis is influenced by the relative size of solute and matrix atoms. (auth)

25928 LIMITING CRITICAL FIELD IN THIN SUPERCONDUCTORS. N. Kusnezov (Lockheed Aircraft Corp., Palo Alto, Calif.). Phys. Rev., 130: 2253-6(June 15, 1963).

The Ginzburg-Landau theory was formulated in a proper form to include the magnetization effect due to penetration of the magnetic field within the superconductor. Modified Ginzburg-Landau equations were obtained and solved for the case of thin films and filaments in vacuo or imbedded in normal material. The resulting expressions describe the behavior of the critical field of thin films and filaments as functions of thickness and temperature. They reduce to Clogston's critical field in the limit of vanishing thickness. They also provide a simple criterion for distinguishing between different types of the superconducting-normal transitions. (auth)

25929 ROTATIONAL EXCITATION AND ELECTRON RELAXATION IN NITROGEN. Michael H. Mentoni and Ronald V. Row (Sylvania Electric Products, Inc., Waltham, Mass.). Phys. Rev., 130: 2312-16(June 15, 1963).

Using the expression given by Gerjuoy and Stein for the cross section for excitation of rotational states in N_2 by monoenergetic electrons, an exact expression for the average electron energy loss rate, (dW_e/dt), is derived in the case of a Maxwellian velocity distribution. The results are used in the interpretation of cross modulation experiments performed at microwave frequencies in an afterglow discharge. Computed results are presented for several gas temperatures, T, in the range 300–735°K with the electron temperature, T_e, being a running variable within 250°K of the gas temperature. It is seen that (dW_e/dt) varies linearly with $(T_e - T)$, when T_e is less than 10% in excess of T; and that the slope, proportional to the inverse electron relaxation time, τ, decreases as $T^{-1/2}$. This is also predicted by an approximate, closed form representation of (dW_e/dt), which agrees extremely well with the exact computation. The experimental data on τ, found by microwave cross modulation techniques, agree well with theory. Using Pack and Phelps' relation between the electron momentum transfer collision frequency ν_m, and T_e, it is found that the G factor varies at $T_e^{-1/2}$, with $G/G_{classical}$ ranging from 55.9 at 300°K, to 14.3 at 735°K. (auth)

25930 ELECTRON CAPTURE BY PROTONS PASSING THROUGH HYDROGEN. T. Pradhan and D. N. Tripathy (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 130: 2317-18(June 15, 1963).

Computational errors in a previous paper on this subject were rectified. The recomputed capture cross sections agree fairly well with experimental data over the entire energy range from 50 to 1000 kev. The disagreement was at energies above 150 kev, in spite of the fact that the approximation scheme adopted was expected to be better at higher than at lower energies. (auth)

25931 BALMER EMISSIONS INDUCED BY PROTON IMPACT ON MOLECULAR HYDROGEN. R. H. Hughes, Sabrina Lin, and L. L. Hatfield (Univ. of Arkansas, Fayetteville). Phys. Rev., 130: 2318-21(June 15, 1963).

Absolute cross sections for the production of H_α, H_β, and H_γ emissions by proton impact on molecular hydrogen were measured. Emissions produced through the process of electron capture into excited states by fast protons are Doppler shifted from emissions produced through dissociative excitation of the target gas, that allows separate measurements of these processes. Comparisons are made with theoretical calculations of proton impact on atomic hydrogen. (auth)

25932 LOW-LYING ENERGY LEVELS OF LANTHANIDE ATOMS AND INTERMEDIATE COUPLING. J. G. Conway and B. G. Wybourne (Univ. of California, Berkeley). Phys. Rev., 130: 2325-32(June 15, 1963). (UCRL-10566)

A detailed examination of the effects of intermediate coupling on the properties of the low-lying levels of lanthanide atoms was made. Particular attention was given to the effects of a breakdown of Russell-Saunders coupling on the energies and magnetic properties of the levels of the ground multiplets. The energy levels were calculated by diagonalization of the combined electrostatic and spin-orbit matrices of the f^n configurations. It is found possible to fit the energy levels of the ground multiplets of Nd I and Sm I to within 2 cm^{-1} of their observed energies using 4f-hydrogenic ratios for the Slater F_k integrals. The g values are found to agree within the experimental errors of the atomic beam measurements. An explanation for the apparent success of the 4f-hydrogenic eigenfunctions is offered and it is demonstrated that the success of these eigenfunctions does not imply that the actual eigenfunctions are hydrogen-like. Tables of the calculated energies and eigenvectors for low-lying levels are given together with the g values calculated in intermediate coupling. The effects of intermediate coupling on the relativistic and diamagnetic corrections to the g values are examined and shown to fall within the range of atomic beam measurements. The importance of intermediate coupling in the actinides is noted. (auth)

25933 INTERACTION POTENTIALS FROM THE VELOCITY DEPENDENCE OF TOTAL ATOM-ATOM SCATTERING CROSS SECTIONS. Erhard W. Rothe, P. K. Rol, and Richard B. Bernstein (General Dynamics/Astronautics, San Diego, Calif.). Phys. Rev., 130: 2333-8 (June 15, 1963).

Methods are described that yield the interatomic potential energy parameters from the velocity (v) dependence of the total scattering cross section (Q). These are applied to measurements of the scattering of lithium by the rare gases. The Lennard-Jones potential is assumed. The cross sections for scattering by argon, krypton, and xenon were measured in a low-energy region, where Q(v) is undulatory. From the extrema velocities the product $\epsilon\sigma$ may be obtained, where ϵ is the depth of the interatomic potential well and σ is the interatomic separation at the zero of potential energy. From the absolute value of Q, the parameter σ may be determined separately. These quantities were also deduced for the scattering by helium and neon, which were studied in the high-energy region. Using the experimental ϵ and σ, theoretical curves of Q(v), calculated by a partial-wave analysis, agree well with the experimental results. A minimum to the number of diatom bound states was also established. (auth)

25934 SIMPLIFIED APPROACH TO THE GROUND-STATE ENERGY OF AN IMPERFECT BOSE GAS. Elliott H. Lieb (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev., 130: 2518-28(June 15, 1963).

The well-known first two terms in the asymptotic density series for the ground-state energy of a Bose gas, $E_0 =$

$2\pi N\rho a[1 + (128/15\sqrt{\pi})(\rho a^3)^{1/2}]$, where a is the scattering length of the pair potential, is ordinarily obtained by summing an infinite set of graphs in perturbation theory. It is shown how this same series may be obtained by elementary methods. The method offers the advantages of simplicity and directness. Another advantage is that the hard-core case can be handled on the same basis as a finite potential no pseudopotential being required. In fact, the analysis of the hard-core potential turns out to be simpler than for a finite potential, as is the case in elementary quantum mechanics. In an Appendix the high-density situation is discussed and it is shown that for a certain class of potentials, Bogoliubov's theory is correct in this limit. Thus, Bogoliubov's theory, which is never correct at low density unless a pseudopotential is introduced, is really a high-density theory. (auth)

25935 THE QUANTUM THEORY OF OPTICAL COHERENCE. Roy J. Glauber (Harvard Univ., Cambridge, Mass.). Phys. Rev., 130: 2529-39(June 15, 1963).

The concept of coherence that was conventionally used in optics is found to be inadequate to the needs of recently opened areas of experiment. To provide a fuller discussion of coherence, a succession of correlation functions for the complex field strengths is defined. The nth order function expresses the correlation of values of the fields at 2n different points of space and time. Certain values of these functions are measurable by means of n-fold delayed coincidence detection of photons. A fully coherent field is defined as one whose correlation functions satisfy an infinite succession of stated conditions. Various orders of incomplete coherence are distinguished, according to the number of coherence conditions actually satisfied. It is noted that the fields historically described as coherent in optics have only first-order coherence. On the other hand, the existence, in principle, of fields coherent to all orders is shown both in quantum theory and classical theory. The methods used in these discussions apply to fields of arbitrary time dependence. It is shown, as a result, that coherence does not require monochromaticity. Coherent fields can be generated with arbitrary spectra. (auth)

25936 STATISTICAL MECHANICAL THEORY OF CONDENSATION. M. Coppersmith and R. Brout (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 130: 2539-59(June 15, 1963).

The cluster expansion for the free energy of the Ising model is reinterpreted as a cluster expansion for the pressure of the lattice gas. It is observed that the free energy of the Ising model is a function of $1 - R^2$, where R is the long-range order, so that the pressure of the lattice gas is a function of $\rho(1 - \rho)$, where ρ is density. The factor $1 - \rho$ comes from the prevention of more than one particle occupying a lattice site. This idea has motivated the development of a real hard-core gas with a weak attractive tail. A cluster expansion is developed in terms of the tail alone and the hard core is treated as a metric. Pressure-volume isotherms are calculated explicitly in the zeroth order or molecular field approximation using the Lennard-Jones potential and good quantitative results are found for the critical parameters as well as a qualitative understanding of the condensation phenomena. The theory of the first-order correction is then outlined and fluctuations of the Ornstein-Zernicke type in the local density are found. The theory of condensation is qualitatively understood in the sense that the Weiss field gives an understanding of ferromagnetism. The theory of the detailed fluctuations in the critical region is equally difficult for both phenomena since the problems are put on the same footing. (auth)

25937 ENERGY-GAP FUNCTION IN THE THEORY OF SUPERCONDUCTIVITY. James C. Swihart (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev., 131: 73-8(July 1, 1963).

The relation between the form of the energy-gap function $\Delta(\epsilon)$ and experimental results for the superconductors with stronger coupling, Pb and Hg, is discussed. It is shown that the critical field curve is affected rather strongly by the form of $\Delta(\epsilon)$ near the Fermi surface, but that the form of $\Delta(\epsilon)$ at distances of a Debye energy or more has little effect. The positive deviation of the critical field from a parabolic indicates that Δ is flat or slightly increasing on moving away from the Fermi surface. Solutions of the BCS integral equation are given for the Bogoliubov, Bardeen-Pines, and Eliashberg interactions. When a screened Coulomb interaction is included, all of these solutions have the necessary form at the Debye energy to explain the anomalous tunneling behavior of Pb. The critical field data eliminate both the Bogoliubov and Bardeen-Pines interactions, and favor the Eliashberg interaction. However, the Pb and Hg critical fields cannot be reproduced with these solutions since the ratio $\Delta(0)/kT_c$ is much too small. (auth)

25938 SUPERCONDUCTIVITY AT HIGH MAGNETIC FIELDS. T. G. Berlincourt and R. R. Hake (Atomics International, Canoga Park, Calif.). Phys. Rev., 131: 140-57(July 1, 1963).

Using pulsed-magnetic-field techniques the magnetic-field-induced superconducting transitions of alloys in the systems Ti-V, Ti-Nb, Ti-Ta, Ti-Mo, Zr-Nb, Hf-Nb, Hf-Ta, U-Nb, and U-Mo were studied. For concentrated alloys the low-current-density resistive critical field H ($J \lesssim 10$ A/cm^2) is nearly independent of the amount of cold working and the relative orientations of magnetic field, current, and anisotropic defect structure. The observed values of $H_r(J = 10)$ peak up sharply in the vicinity of ~4.5 valence electrons per atom, an electron concentration where peaking also typically occurs for such defect-independent transition metal alloy parameters as superconducting transition temperature, thermodynamic critical field, and electronic specific heat coefficient. All the evidence suggests that in these alloys $H_r(J = 10)$ is determined principally by bulk electronic parameters, rather than by the nature of extended lattice defects. This view is further supported by the observation that, for several Group V-rich, Group IV-Group V transition metal alloys, excellent quantitative agreement is achieved in adjustable-parameter-free comparisons of $H_r(J = 10)$ with H_{c2}, the upper critical field predicted on the basis of bulk electronic parameters by the Ginzburg-Landau-Abrikosov-Gor'kov (GLAG) theory for the case of negative surface energy. For certain ranges of alloy composition, it appears that normal-state paramagnetic free-energy considerations, ignored in the GLAG theory, impose limitations on $H_r(J = 10)$ in good accord with the theoretical predictions of Clogston. Additional experimental results are reviewed, and it is argued that a comprehensive theoretical understanding of high-field superconductivity in bulk materials may be achieved on the basis of the GLAG theory, modified to include paramagnetic free-energy terms, and extended to consider transport supercurrents stabilized in a manner similar to that suggested by Gorter and Anderson. The a priori assumptions of Mendelssohn's filamentary-mesh model appear, on the other hand, to be inadequate for a suitable description. (auth)

25939 MULTIPLE SCATTERING OF ELECTRONS AND POSITRONS. I. B. Strong and R. R. Roy (Pennsylvania State Univ., University Park). Phys. Rev., 131: 198-202(July 1, 1963).

Multiple scattering of 2650 electron and 1887 positron tracks was studied in nitrogen by cloud-chamber techniques. The theory of Williams with limiting angles due to Bethe best describes the multiple scattering of electrons and positrons in the momentum range between 1000 and 6000 G-cm. The theory of Molière is less satisfactory, underestimating the multiple scattering above 2000 G-cm by an appreciable amount. Analysis of positron-electron differences suggests that electron multiple scattering exceeds that for positrons by, at most, a few percent. This is in agreement with theoretical predictions of Nigam, Sundaresan, and Wu, and Mohr. No evidence is found for the very large differences claimed in most other experimental work. (auth)

25940 INTERACTION ENERGY BETWEEN A HELIUM ATOM AND A HYDROGEN MOLECULE. Charles S. Roberts (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 131: 203-9(July 1, 1963).

The interaction energy between a helium atom and a hydrogen molecule was calculated from first principles using a simple wave function made up of 1S orbitals centered on the three nuclei. All molecular integrals encountered were accurately calculated using an IBM 709 digital computer. If r represents the distance measured along a line drawn from the helium nucleus to the midpoint of the hydrogen molecule bond, and if γ is the angle between this line and the axis of the hydrogen molecule, then the interaction energy was computed at 15° increments of γ from r = 3.8 to 5.2 a.u. With the H_2 bond length held constant at 1.406 a.u. it was found possible to represent the computed interaction energy quite accurately. The spherical average of the computed interaction energy agrees quite closely with an interaction energy obtained from gas diffusion measurements. It is shown that it is impossible to represent the calculated interaction energy by means of a dumbbell-type function, i.e., a function of the form $f(\rho_{ac}) + f(\rho_{bc})$, where f(x) is some suitable chosen function and ρ_{ac} and ρ_{bc} represent the distance from the helium nucleus to the two hydrogen nuclei, respectively. Results are also presented for a slightly elongated H_2 bond length of 1.486 a.u. (auth)

25941 INELASTIC SCATTERING FROM A DIATOMIC MOLECULE: ROTATIONAL EXCITATION UPON COLLISION BETWEEN He AND H_2 AND H_2 AND H_2. Charles S. Roberts (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 131: 209-17(July 1, 1963).

The formalism developed by Arthurs and Dalgarno was used in the distorted wave approximation to calculate the inelastic scattering cross section for rotational excitation from the j = 0 to the j = 2 rotational state in collisions between a helium atom and a hydrogen molecule or two hydrogen molecules. All necessary computations were done with a digital computer, thus, allowing the Arthurs-Dalgarno formalism to be applied with no added approximations. The interaction energy between He and H_2 obtained previously was used for the He - H_2 calculation while the interaction energy given by Takayanagi was used for the $H_2 - H_2$ problem. Values for the total inelastic cross sections are given as well as graphs for the He - H_2 differential scattering cross section. Incident kinetic energies up to only 0.25 ev in the center-of-mass system were considered; for these low energies, vibrational or electronic excitation is impossible so that change in rotational quantum number is the only inelastic process possible. The results obtained for the $H_2 - H_2$ cross section do not agree with the rate of de-excitation from the j = 2 rotational level in H_2 gas as measured by dispersion experiments with ultrasonic waves. The disagreement may be due to an incorrect $H_2 - H_2$ interaction potential or failure to consider all important de-excitation mechanisms. (auth)

25942 ION ENERGIES AT THE CATHODE OF A GLOW DISCHARGE. W. D. Davis and T. A. Vanderslice (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 131: 219-28(July 1, 1963).

The energy distribution of ions striking the cathode in a glow discharge was measured for a series of gases including hydrogen, helium, neon, and argon. Standard ultrahigh vacuum techniques were used to maintain a high degree of gas purity. The ions were detected by placing a small pinhole in the cathode of a glow discharge and analyzed for energy by means of a sector-type electrostatic analyzer. The ion species was determined with a conventional magnetic analyzer and the resulting ion beam intensity measured with an electron multiplier. An oscilloscope display gave the ion-energy distribution for a particular ion species. A simple theory involving assumptions that the ions originated in the negative glow and undergo primarily symmetrical charge transfer as they pass through the cathode dark space to the cathode gives results that are in most cases in good agreement with experiment. The charge-transfer cross sections determined are in reasonable agreement with other published data. (auth)

25943 RESONANT CHARGE EXCHANGE IN ATOMIC COLLISIONS. William Lichten (Univ. of Chicago). Phys. Rev., 131: 229-38(July 1, 1963).

The remarkable results of Everhart et al., in observing resonant charge exchange in wide angle ion-atom collisions, are discussed in terms of the well-known impact parameter method. It is shown that previous theories based on adiabatic potential curves are inconsistent with the results of $He^+ - He$ experiments. However, experimental results are correctly predicted from a Heisenberg representation consisting of the basis set of single configuration wave functions built up from molecular orbitals. This set includes virtual states. In this representation, the collision can be assumed to be adiabatic except for very short or very long collision times. The case of double charge exchange is treated, and it is shown that a three-state approximation is required. The presence of phase shifts in empirical equations is a result of the breakdown of interference at zero-collision time. Damping is discussed. The results include the work of others and are general enough to include new cases. In particular, charge exchange in He^{++}-He, $Li^+ - Li$, and $Li^{++} - Li$ collisions is discussed and predictions of experimental results are made. (auth)

25944 POSITRON MEAN LIVES IN SCANDIUM, YTTRIUM, AND THE RARE-EARTH METALS. J. L. Rodda and M. G. Stewart (Ames Lab., Ames, Iowa). Phys. Rev., 131: 255-8(July 1, 1963). (IS-611)

Positron mean lives relative to that in aluminum are reported for scandium, yttrium, and all of the stable rare-earth metals. An automatic cycling procedure allows these relative measurements to be made with an accuracy of $\pm 3 \times 10^{-12}$ sec. The average positron lifetime in the trivalent rare earths and in yttrium is 0.675×10^{-10} sec longer than the positron lifetime in aluminum, with an average deviation of $\pm 0.035 \times 10^{-10}$ sec. The positron lifetimes in the divalent rare earths are appreciably longer, while the lifetime in scandium is somewhat shorter. The experimental results indicate a correlation between the positron lifetime and the conduction electron density, and they show that the 4f electrons do not participate in the annihilation process. (auth)

25945 PRESSURE BROADENING AS A PROTOTYPE OF RELAXATION. U. Fano (National Bureau of Standards, Washington, D. C.). Phys. Rev., 131: 259-68(July 1, 1963).

The theoretical results of Baranger, Kolb, and Griem on pressure broadening are rederived by a more compact and flexible procedure directly applicable to other relaxation processes. Pressure broadening is worked out to first order in the pressure, including previously disregarded corrections. The procedure adapts the concepts and techniques of scattering theory to the Liouville representation of density matrices. Its key quantity is a frequency-dependent relaxation operator introduced by Zwanzig. (auth)

25946 GRAVITATIONAL RADIATION FROM POINT MASSES IN A KEPLERIAN ORBIT. P. C. Peters and J. Mathews (California Inst. of Tech., Pasadena). Phys. Rev., 131: 435-40(July 1, 1963).

The gravitational radiation from two point masses going around each other under their mutual gravitational influence is calculated. Two different methods are outlined; one involves a multipole expansion of the radiation field, while the other uses the inertia tensor of the source. The calculations apply for arbitrary eccentricity of the relative orbit, but assume orbital velocities are small. The total rate, angular distribution, and polarization of the radiated energy are discussed. (auth)

25947 SOLUTIONS OF THE DENSITY MATRIX-PAIRING TENSOR EQUATIONS OF SUPERCONDUCTIVITY THEORY. W. H. Young (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 131: 476-9(July 1, 1963).

An algorithm is provided for writing down explicitly all solutions of the density matrix-pairing tensor equations that arise in the generalized Bogoliubov-Valatin transformation approach to superconductivity theory. Certain simpler special cases are then examined. Finally reasons are given indicating that our solutions should provide a practical computational tool in many-body theory. (auth)

25948 RADIAL DISTRIBUTION FUNCTIONS FOR LONG-RANGE FORCES. A. A. Broyles, H. L. Sahlin, and D. D. Carley (Univ. of Florida, Gainesville). Phys. Rev. Letters, 10: 319-21(Apr. 15, 1963).

Radial distribution functions calculated for a classical electron gas with long-range potentials by the Born-Green and Percus-Yevick equations are compared with results obtained by the Debye-Hückel theory and by a new method. The Percus-Yevick equation appears to be superior to the Born-Green equation for functions with long-range potentials. (D.C.W.)

25949 EXACT SOLUTION OF THE PERCUS-YEVICK INTEGRAL EQUATION FOR HARD SPHERES. M. S. Wertheim (New York Univ., New York). Phys. Rev. Letters, 10: 321-3(Apr. 15, 1963).

The equation of state and the pair distribution for the Percus-Yevick integral equation for the radial distribution function of a classical fluid are obtained in closed form for the prototype of interacting hard spheres. (D.C.W.)

25950 SHAPE RESONANCES IN SUPERCONDUCTING THIN FILMS. John M. Blatt and Colin J. Thompson (New York Univ., New York and Univ. of New South Wales, Kensington, Australia). Phys. Rev. Letters, 10: 332-4 (Apr. 15, 1963).

Equations taking into account the Coulomb potential generated by the charge density of the electrons plus an assumed uniform background of positive charge were solved for a superconducting slab. Exceptionally large resonance effects in the energy gap parameter were noted whenever an energy level, for motion perpendicular to the slab faces, passed through the Fermi surface as the slab thickness varied. (D.C.W.)

25951 IMAGE OF THE PHONON SPECTRUM IN THE TUNNELING CHARACTERISTIC BETWEEN SUPERCONDUCTORS. J. M. Rowell, P. W. Anderson, and D. E. Thomas (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 10: 334-6(Apr. 15, 1963).

Structure in the energy gap function of superconducting lead related to its phonon spectrum was resolved, and much of it was assigned to specific Van Hove singularities expected from neutron measurements of the Pb phonon spectrum. Phonon structure in Al that correlates with the known phonon spectrum of that metal, and in Sn, was found. A model for Pb that is consistent with the observed gap and quantitatively predicts the overall shape of the density of states vs energy curve was developed. (D.C.W.)

25952 EFFECTIVE TUNNELING DENSITY OF STATES IN SUPERCONDUCTORS. J. R. Schrieffer, D. J. Scalapino, and J. W. Wilkins (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Letters, 10: 336-9(Apr. 15, 1963).

Results of a theoretical determination of the tunneling characteristic, that agree well with structure observed in the I-V characteristic of superconducting metals, are presented. Experimental and theoretical curves for the density of states show good agreement. (D.C.W.)

25953 LYMAN ALPHA PRODUCTION IN PROTON-RARE GAS COLLISIONS. Donavon Pretzer, Bert Van Zyl, and Ronald Geballe (Univ. of Washington, Seattle). Phys. Rev. Letters, 10: 340-2(Apr. 15, 1963).

Cross sections for Lyman alpha radiation production in proton reactions at 1 to 25 kev with Ne, He, Xe, Ar, and Kr were measured. Two prominent maxima were observed in the Ar, Kr, and Ne reaction cross sections while the He(p) cross section has a maximum with a shoulder on its high-energy side. The cross section for the Xe(p) has a 10-kev peak and gives indication of another at very low proton energy. (D.C.W.)

25954 LASER BEAM INDUCED ELECTRON EMISSION. David Lichtman and J. F. Ready (Honeywell Research Center, Hopkins, Minn.). Phys. Rev. Letters, 10: 342-5(Apr. 15, 1963).

The emission of electrons by laser beam targets was investigated. A ruby laser was used with a carbon target while carbon and tungsten targets were used with a neodymium laser. The results indicate that the emission arises from the extremely rapid heating of the focus spot to very high temperature and that very high-current-density electron pulses of extremely short pulse width can be produced in this manner. (D.C.W.)

25955 CAUSE OF THE OBSERVED POLARIZATION OF ELECTRON-INDUCED RADIATION FROM HELIUM. Robert H. McFarland (Univ. of California, Livermore). Phys. Rev. Letters, 10: 397-8(May 1, 1963). (UCRL-7283)

The resulting polarization and excitation efficiency of electron-induced radiation from helium is investigated. At threshold, electrons elastically scattered from the beam have insufficient energy to excite $\lambda = 4922$ Å radiation so that all radiation observed is from the beam and the polarization conforms to theory. As the electron energy increases so does the number of elastically scattered electrons that are capable of exciting radiation that is radially polarized. Thus the observed polarization decreases with energy until these scattered electrons have sufficient en-

ergy to preferentially excite higher levels or ionize the helium atom. (C.E.S.)

25956 EXPERIMENTAL EVIDENCE FOR THE INCREASE OF HEAVY ION RANGES BY CHANNELING IN CRYSTALLINE STRUCTURE. G. R. Piercy, F. Brown, J. A. Davies, and M. McCargo (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. Letters, 10: 399-400 (May 1, 1963).

The range of 40-kev Kr^{85} ions in amorphous Al_2O_3 and in polycrystalline Al was measured. The range distribution in the polycrystalline Al showed an exponential behavior due to the crystalline structure. The existence of a channeling process was strongly suggested by the striking qualitative resemblance between experiment and calculation. (C.E.S.)

25957 PHENOMENA ALONG THE hcp-bcc TRANSITION LINE OF He^3 AND He^4. A. F. Schuch, W. C. Overton, Jr., and R. Brout (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 10: 429-31(May 15, 1963). (LADC-5668)

The behavior of the Debye temperature along the crystal phase transition line and along the melting point curve of He^3 and He^4 is investigated to obtain information on the hexagonal-close-packed to body-centered-cubic transition (hcp to bcc). The solid phase transition occurs at the point of inflection of the potential energy vs nearest neighbor distance curve. In the bcc phase the force constant is governed predominantly by the zero-point repulsion plus some attraction, whereas in the hcp phase it is governed mostly by the zero-point repulsion. (C.E.S.)

25958 HEAT CAPACITY OF THE γ PHASE OF He^4. Guenter Ahlers (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 439-41(May 15, 1963).

The properties of the γ phase of He^4 were investigated to determine the lattice heat capacity difference of the body-centered-cubic and hexagonal-close-packed phases, the isotope effect in the body-centered-cubic phase, and the heat capacity of γ-He^4. Considerable information was gained on the detailed behavior of He^4 along the various phase boundaries. (C.E.S.)

25959 ROTATIONAL MAGNETIC MOMENTS OF DIATOMIC ALKALIS. R. A. Brooks, C. H. Anderson, and N. F. Ramsey (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 10: 441-3(May 15, 1963).

The rotational magnetic moments of H_2, Li_2, Na_2, K_2, Rb_2, and Cs_2 were measured by a method that produces a series of quantum transitions that lead to large net changes of magnetic moments. Measurements of these rotational magnetic moments were previously impossible due to the smallness of the gyromagnetic ratios. (C.E.S.)

25960 EXOELECTRON EMISSION SPECTRA OF ALKALI CHLORIDES. P. Petrescu (Inst. of Physical Research, Rumanian Academy of Sciences, Bucharest). Phys. Status Solidi, 3: 950-60(1963). (In German)

The spectra of exoelectron emission (as a function of the wavelength of the exciting radiation) of polycrystalline NaCl, KCl, RbCl, and CsCl samples were measured. The levels of the principal centers (F-centers) and secondary centers (M-centers etc.), as well as their formation and development under the action of radiation, were investigated. Further studies were made on F- and M-centers of RbCl–KCl-mixed crystals. (auth)

25961 RELATIVE OPTICAL EXCITATION FUNCTIONS OF HELIUM (EXCITATION BY ELECTRONS). C. Smit, H. G. M. Heideman, and J. A. Smit (Universiteit, Utrecht). Physica, 29: 245-56(Apr. 1963). (In English)

When helium atoms are excited by electrons, the resulting light shows a line spectrum. The intensity of the line depends on the energy of the electrons; the dependence is given by the so-called optical excitation function of the line. Excitation is achieved by a beam of electrons of adjustable velocity in helium. The beam current is low (10 to 50 μA) and the helium pressure is also low (about 5×10^{-3} torr), so as to avoid errors from space charge. Since under these circumstances the light intensities are very small, a special photon-counting method is developed for the measurement. In the region immediately after the excitation energy many of the excitation curves show a detailed structure. (auth)

25962 NUCLEAR MAGNETIC RESONANCE. R. E. Richards. Proc. Chem. Soc., 101-6(Apr. 1963).

A survey is presented of some of the properties of nuclear resonances with reference to possible use by chemists. The principles of nuclear magnetic and electron spin resonance are described briefly. Chemical shifts are considered, and the various ways in which interactions between the nuclear magnetic moments of a sample may affect the spectrum are discussed for the following: static dipole interactions, spin-spin coupling, relaxation times, and electric quadrupole interactions. (D.L.C.)

25963 RADIOISOTOPIC METABOLIC DETECTION OF POSSIBLE MARTIAN LIFE-FORMS. A. H. Heim. Proc. Lunar Planetary Explor. Colloq., Santa Monica, Calif., 1962, 3: No. 1, 37-46(May 5, 1963).

The feasibility of a radioisotopic biochemical experiment for extraterrestrial life detection was established. A medium was developed that supports the evolution of detectable levels of $C^{14}O_2$ by pure cultures of representative bacteria, streptomycetes, fungi, and algae within a period ranging from minutes to several hours. Mixed populations in soils also respond in less than one hour. An instrument weighing 1.5 pounds was developed and field tested. In operation, a soil sample is obtained by ejection of two 25-foot lengths of adhesive-impregnated string that are reeled back, with collected soil particles, into a culture chamber. Here a radioactive medium is supplied, and a solid-state radiation detector monitors metabolically evolved radioactive gases. (auth)

25964 SOLAR WEATHER FORECASTING. F. C. Jonah. Proc. Lunar Planetary Explor. Colloq., Santa Monica, Calif., 1962, 3: No. 1, 53-66(May 5, 1963).

Before the safety of space travel for a given period of time can be determined, it is imperative that scientific experiments be devised to solve the problems presented by radiation belts, galactic cosmic rays, and, especially, solar radiation following major flares. Many statistical studies have failed to yield convincing conclusions as to the variation in activity of the sunspot groups, or the radiation intensity from the high-energy proton streams that result from major solar flares. The ability to produce an accurate weather forecast for space travel is considered, after a detailed discussion of the major flares occurring in 1958. (auth)

25965 FREQUENCY AND MAGNITUDE OF SOLAR COSMIC-RAY EVENTS AS MEASURED WITHIN THE GEOMAGNETIC FIELD. L. S. Pearce. Proc. Lunar Planetary Explor. Colloq., Santa Monica, Calif., 1962, 3: No. 1, 67-74(May 5, 1963).

The polar cap absorption data obtained from Warwick and Haurwitz are used to compute the peak flux, time-integrated flux, and dosage for approximately 40 solar high-energy particle increases. From the sampling of polar cap absorption events, the expected number versus

size is computed. These data are then related to the cycle of solar flare activity. (auth)

25966 PHYSICAL PROPERTIES OF THE RADIATION BELTS. S. F. Singer. Proc. Lunar Planetary Explor. Colloq., Santa Monica, Calif., 1962, 3: No. 1, 75-86(May 5, 1963).

Solar high-energy particles consist mainly of protons with energies greater than 80 Mev. Such protons are of primary importance where the biological effects of radiation are concerned. The neutron-albedo theory was proposed to explain the mechanism by which these protons become trapped in the geomagnetic field. The intensity of the trapped radiation is found to be dependent on the density of the atmosphere. Data for the 12 November 1960 solar event are cited as an example of the integrated flux and radiation dosages that may be present during a class 3+ solar flare. Such information is pertinent to the determination of radiation shielding requirements for manned spacecraft. (auth)

25967 THE DERIVATIONS OF A NEW DISTRIBUTION FUNCTION IN RADIOBIOLOGY. A. Bierman. Proc. Lunar Planetary Explor. Colloq., Santa Monica, Calif., 1962, 3: No. 1, 99-105(May 5, 1963).

Radiation is considered as a tool in determining the structure of a biological system and to conclude something about the effects of radiation on that system. The target theory assumes that a biological effect occurs in a system or cell that contains targets that are ionized by radiation. Equations to determine the surviving populations of sites, in relation to dosage are derived. This leads to the derivation of a set of experiments for determining explicit measurements of the hit-multiplicity of a system. (auth)

25968 A NEW ANALYTICAL METHOD FOR DETERMINING DOSE RATES IN ABSORBER SYSTEMS EXPOSED TO SPACE RADIATION. J. E. Corry and D. E. Stogryn. Proc. Lunar Planetary Explor. Colloq., Santa Monica, Calif., 1962, 3: No. 1, 107-16(May 5, 1963).

A new analytical method for determining dose rates in absorber systems exposed to space radiation is described in the context of the problematic status of space radiation measurements, biological effects criteria, and the available techniques used to calculate dose rates. (auth)

25969 SOME RADIOBIOLOGICAL ASPECTS OF EARLY MANNED SPACE FLIGHT. W. H. Langham (Los Alamos Scientific Lab., N. Mex.). Proc. Lunar Planetary Explor. Colloq., Santa Monica, Calif., 1962, 3: No. 1, 117-34(May 5, 1963). (LADC-5499)

Current radiobiological information is reviewed with regard to its bearing on the potential radiation problems associated with manned space flight. Extensive studies of the acute and chronic effects of radiation exposure were conducted. At present, however, the physical data are not adequate to define the radiation environment in space, especially in estimating the solar flare intensities and similar phenomena. When the quality and nature of radiations are varied, more and greater modifications in response are encountered. Relatively realistic radiation protection guides are proposed, but they are tentative, pending additional experimental information on several biological parameters. (auth)

25970 THE POLARIZATION BY MERCURY OF 1 TO 2 kev ELECTRONS. P. J. Bunyan (Univ. of Melbourne). Proc. Phys. Soc. (London), 81: 816-19(May 1, 1963).

Calculations of the energy and angular dependence of the polarization of 1 to 2 kev electrons elastically scattered from mercury agree qualitatively with experiment, a maximum 90° polarization occurring at 1.5 kev as found experimentally. (auth)

25971 THE BOLTZMANN EQUATION FOR INHOMOGENEOUS ELECTRIC FIELDS. G. V. Chester (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 81: 938-48(May 1, 1963).

A rigorous derivation is given of the conventional Boltzmann equation for a metal in an inhomogeneous electric field E(x,t). It is assumed that the electrons are scattered elastically by static impurities. The equation is shown to be valid provided the following conditions hold: $\hbar/\tau \ll \eta$, where τ is the scattering time and η the Fermi energy of the system; $\lambda \gg \lambda_F$, r_0 where λ is the smallest wavelength present in E(x,t), λ_F is the Fermi wavelength of the electrons and r_0 is the range of the scattering potential; $\hbar\omega \ll E_a$, where ω is the largest frequency in E(x,t) and E_a is an energy of the order of magnitude of the Fermi energy. (auth)

25972 ABSOLUTE PAIR CROSS SECTIONS AT 1·119 Mev. J. Rama Rao, V. Lakshminarayana, and S. Jnanananda, (Andhra Univ., Waltair, India). Proc. Phys. Soc. (London), 81: 949-55(May 1, 1963).

Absolute pair cross sections in the elements Cu, Zr, Rh, Sn, Ta, Pt, Au, and Pb for gamma rays of energy 1.119 Mev are determined, using a scandium-46 source of intensity 1 curie and a coincidence scintillation spectrometer. The results are found to support the general viewpoint that Bethe-Heitler theory fails at energies of this magnitude. Good agreement is observed between the present experimental value for lead and the value reported by previous investigators. The usual Z dependence formula valid at high energies is, however, found to be inadequate at this energy. A modified formula of the type $\sigma = \sigma_{BH}[1 + dZ^2 \exp(-bZ)]$ for the Z dependence of the pair cross section is found to give a better fit of the experimental data. (auth)

25973 ON THE ABSOLUTE INTENSITY OF EMISSION OF CHARACTERISTIC X RADIATION. V. Metchnik and S. G. Tomlin (Univ. of Adelaide). Proc. Phys. Soc. (London), 81: 956-64(May 1, 1963).

The theoretical discussion of Worthington and Tomlin published in 1956 was modified to allow for electron scattering within the target, and the results of the two theories are compared with those of an extensive series of measurements of the absolute intensities of emission of characteristic Kα radiation from thick targets of copper, silver, and chromium. Good agreement was found between various methods of intensity measurement and the experimental results are in satisfactory accord with the modified theory. (auth)

25974 RESONANCE IN ELASTIC SCATTERING OF ELECTRONS BY HELIUM ATOMS. R. J. Fleming and G. S. Higginson (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 81: 974-6(May 1, 1963).

In agreement with Schulz, resonance was observed in the elastic collision cross section for electrons in helium. This occurs at approximately 0.5 ev below the 2^3S excitation threshold and leads to a temporary decrease of 6% in the value of the cross section. A compound He^- ion state may be involved. (auth)

25975 IONIZATION PROCESSES IN GASES AND THEIR APPLICATION TO ENERGY CONVERSION SYSTEMS. I. Fells (Univ. of Sheffield, Eng.). Pure Appl. Chem., 5: 513-28(1962). (In English)

A treatment is presented of the possibility of using a high-velocity ionized gas stream in magnetohydrodynamic

(MHD) power generation. The processes leading to abnormal ionization in flames are discussed. Some of the problems involved in gaseous MHD generators are outlined. The energy transfer mechanism between charged and uncharged particles in a strong magnetic field is considered. It is concluded that a more sophisticated thermodynamic cycle than that of the simple linear, crossed field MHD generator is needed. (D.L.C.)

25976 DETERMINATION OF CHARGED PARTICLE BEAM SHAPE IN ELECTROSTATIC FIELD. V. S. Kuznetsov. Radiotekhn. i Elektron., 7: 1385-92(Aug. 1962). (In Russian)

Methods are developed for determining the shapes of charged particle beams in a uniform electrostatic field considering space charge. Working nomograms are analyzed, and it is shown that the numerical solution offered by H. Mose (Wireless Eng., 22: 316(1956)) has only limited application. (tr-auth)

25977 ION FOCUSING OF HOLLOW CYLINDRICAL ELECTRON BEAM. L. E. Bakhrakh and P. A. Turlov. Radiotekhn. i Elektron., 7: 1393-9(Aug. 1962). (In Russian)

Geometric parameters for ionic focusing of a hollow cylindrical electron beam in a gas-filled space were analyzed. The equilibrium radii of beam edge pulsations are determined, and their dependence on focusing parameters was investigated. (tr-auth)

25978 INELASTIC SCATTERING OF ELECTRONS AND ELECTRON SECONDARY EMISSION OF SOLIDS. I. M. Bronshtein and B. S. Fraiman. Radiotekhn. i Elektron., 7: 1643-8(Sept. 1962). (In Russian)

The mean electron paths in Ni, Cu, Ca, Tl, Sn, Ge, Sr, Ag, and In were determined. The δ-η diagram was used to evaluate the role of inelastic-reflected electrons in electron secondary emission in Ga, Ge, In, Sn, Sr, and Tl and for determining electron secondary emission parameters: λ, S, δ, and δ_0. The influence of work function on electron secondary emission was analyzed. (tr-auth)

25979 SPUTTERING OF STAINLESS STEEL AND TANTALUM BY 5 TO 30 Kev DEUTERIUM AND KRYPTON IONS. M. I. Guseva. Radiotekhn. i Elektron., 7: 1680-5 (Sept. 1962). (In Russian)

Sputtering of stainless steel and tantalum by 5 to 30 kev deuterium and krypton was measured in a 30-ton electromagnetic separator with 180° focusing. The ion current density on the target was 500 $\mu a/cm^2$ for krypton and 3 to 5 ma/cm^2 for deuterium. An increase in Kr ion energy from 5 to 30 kev resulted in sputtering coefficient increases from 2 to 4.96 and from 1.26 to 2.97 atoms/ion for stainless steel and Ta, respectively. The obtained data are in agreement with theoretical calculations presented by P. K. Rol et al. (Physica, 26: 11, 1000(1960)). The constant K in Rol's formula was determined for tantalum ($K = 0.9 \times 10^{-11}$ m/ev) and stainless steel (2.47×10^{-11} m/ev). (tr-auth)

25980 WAVE CONCENTRATION OF CHARGE CARRIERS IN MOVING IONIZED GAS. O. R. Konenko and V. L. Granovskii. Radiotekhn. i Elektron., 7: 1795-8(Oct. 1962). (In Russian)

A one-dimensional ionized gas flow with periodically changing charge concentration at the initial cross sections z = 0 was analyzed. It is shown that the initial changes in the concentration should spread as damped waves due to carrier diffusion. The wave damping coefficient and the wave number are calculated as functions of the carrier diffusion coefficient and the rate of flow. The results can be used for determining the flow and carrier diffusion rates. (tr-auth)

25981 MICROWAVE RADIATION OF A DISCHARGE IN AN ION PUMP WITH COLD CATHODES. E. M. Reikhrudel, G. V. Smirnitskaya, and E. P. Sheretov (Moscow State Univ. and Ryazan Radiotechnical Inst., USSR). Radiotekhn. i Elektron., 7: 1809-15(Oct. 1962). (In Russian)

An investigation was made of high-frequency oscillations appearing in the discharge of cold-cathode ion pumps in longitudinal magnetic fields. The peculiarities of electron motion in an ion pump are used in developing relations between oscillations, discharge gap geometry, and discharge parameters. The relations are in good agreement with experimental data. Rotating electrons in the anode plane and electrons oscillating between the cathode planes form space charges. Effects of space charge on oscillation frequencies are discussed. (tr-auth)

25982 MUTUAL CORRELATION FUNCTIONS OF AMPLITUDE PHASE FLUCTUATIONS OF A WAVE PROPAGATING IN NON-UNIFORM MEDIA. Yu. A. Ryzhov. Radiotekhn. i Elektron., 7: 1824-5(Oct. 1962). (In Russian)

A group of formulas was developed for the mutual correlation of fluctuation level and plane wave phase in locally-uniform and in isotropic-turbulence media. (R.V.J.)

25983 GEOMETRIC OPTICS OF AN ANISOTROPIC DIELECTRIC. Yu. A. Zaitsev. Radiotekhn. i Elektron., 7: 1826-9(Oct. 1962). (In Russian)

A group of formulas was developed for electromagnetic wave structure in anisotropic dielectrics. It is shown that field vector rotations in a plane perpendicular to the beam vector are functions of the beam and the medium. (R.V.J.)

25984 ENERGY LOSS OF LIGHT IONS IN THIN METALLIC FOILS. Yu. V. Gott and V. G. Tel'kovskii. Radiotekhn. i Elektron., 7: 1956-61(Nov. 1962). (In Russian)

Measurements were made of specific energy losses of 2 to 15 kev H, D, and He ions in passing through thin metallic foils. It was noted that at velocities from 2×10^7 to 2×10^8 cm/sec the main energy loss takes place during collisions with free electrons. (tr-auth)

25985 THEORY OF ION-ELECTRON EMISSION. E. S. Parilis. Radiotekhn. i Elektron., 7: 1979-87(Dec. 1962). (In Russian)

A review is given of up-to-date data on ion-electron emission in metals. 45 references. (tr-auth)

25986 ENERGY CALCULATIONS FOR UNIFORMLY MOVING CHARGED PARTICLES IN DELAYING STRUCTURES. E. L. Burshtein and G. V. Voskresenskii. Radiotekhn. i Elektron., 7: 2033-6(Dec. 1962). (In Russian)

An energy-balance equation was used in the calculation of wave amplitudes excited by a moving charge in an arbitrary damping structure, uniform along its axis. A relation binding the waveguide damping coefficient in the structure to the damping coefficient for Cherenkov-Vavilov radiation was obtained. (tr-auth)

25987 PLANE ELECTROMAGNETIC WAVE DIFFRACTION BY IDEALLY CONDUCTING LARGE DIAMETER RING. Yu. A. Erukhimovich and Yu. V. Pimenov. Radiotekhn. i Elektron., 8: 394-9(Mar. 1963). (In Russian)

The problem of plane electromagnetic wave diffraction by an ideally-conducting large-diameter ring was resolved by a Huygens-Khirchhoff method. The second field components were described by universal functions. The curves (E^0_φ) calculated for ka = 5 and 10 were compared with published data. (tr-auth)

25988 ELEMENTARY PROCESSES NEAR SURFACES IN A GAS DISCHARGE. V. I. Rydnik and B. M. Yavorskii. Radiotekhn. i Elektron., 8: 639-45(Apr. 1963). (In Russian)

A new method was developed for estimating the neutralization of slow ions and deactivation of slow metastable atoms near metal and dielectric surfaces. The results were in agreement with results obtained by perturbation methods and by collision theory. Relations between potential and kinetic collisions near surfaces were also analyzed. (tr-auth)

25989 MASS SPECTROMETRY OF SECONDARY ION EMISSION IN BOMBARDMENT OF PLATINUM BY ARGON IONS. Ya. M. Fogel, R. P. Slabospitskii, and A. S. Slavnyi (Khar'kov State Univ.). Radiotekhn. i Elektron., 8: 684-90 (Apr. 1963). (In Russian)

Mass-spectrometric analysis of secondary positive and negative ions produced by Ar^+ bombardment of Pt at 22 kev was investigated. Variations in secondary emission mass spectra appearing with N_2, O_2, NH_3, NO, and H_2O atmospheres were analyzed. The number of knock-out ions as a function of target temperature was estimated. (tr-auth)

25990 CALCULATIONS OF WAVES IN ELECTRON BEAMS WITH HIGH-DENSITY SPACE CHARGE. A. D. Vlasov. Radiotekhn. i Elektron., 8: 718-20(Apr. 1963). (In Russian)

Space charge wave parameters were calculated without using the simplified assumption $\omega_{II} < \omega$ and considering relativistic effects. The method can be used for accurately evaluating propagation constants, frequency, wavelength of space charge, and electron conductance introduced by a beam in a resonator. (R.V.J.)

25991 METHOD OF FORMING FINE HOLES OF NEAR ATOMIC DIMENSIONS. R. L. Fleischer, P. B. Price, and R. M. Walker (General Electric Research Lab., Schenectady, N. Y.). Rev. Sci. Instr., 34: 510-12(May 1963).

A method of forming small holes in certain materials is described. The material is first exposed to massive, high energy particles such as fission fragments and is then immersed in a chemical etching solution which dissolves the damaged material along the paths of the particles. With this technique it is possible to form holes which are as small as 25 Å in diameter and are up to ~10 μ long. The hole diameters can be increased at will from the minimum size by continued etching. A density of up to $\sim 10^{11}$ holes/cm^2 can be attained by a short irradiation in a typical reactor. The holes can be accurately aligned by collimating a beam of fission fragments. Fine holes have been formed in this way in a number of nonmetallic materials including glass, mica, and other silicate minerals. (auth)

25992 FEASIBILITY OF CONTAINMENT OF QUANTUM MAGNETIC DIPOLES. C. V. Heer (Ohio State Univ., Columbus). Rev. Sci. Instr., 34: 532-7(May 1963).

The design of a "magnetic bottle" for neutral quantum magnetic dipoles is considered. It is shown that atoms or molecules with a magnetic moment and described by a wavefunction $\psi(Jm_J)$ may be confined to the interior of a toroid for suitable values of J and m_J for periods of the order of seconds. The magnetic field which is required for containment is obtained by a current distribution which is formed by six current loops symmetrically placed on the toroid surface. Adjacent current loops carry current in opposite directions. For large toroids the magnetic field distribution approaches that of the hexagonal array of linear currents used by Friedberg for focusing magnetic dipoles. The trajectories inside the toroid, the design of an experimental system, and the limitation of the "magnetic bottle" are considered. Containment of atomic hydrogen and the metastable states of some gases seem feasible, and the containment of neutrons, other atomic systems, and molecules awaits improved techniques of thermal moderation. (auth)

25993 WINDOWLESS TUBES FOR X-RAY SPECTROSCOPY. Ralph W. G. Wyckoff and Franklin D. Davidson (Univ. of Arizona, Tucson). Rev. Sci. Instr., 34: 572-3 (May 1963).

Using a demountable x-ray tube it is shown that elimination of the window between its target and a "fluorescing" sample increases the intensity of the characteristic x rays excited in a light element by as much as 100-fold without loss of stability in the tube operation. The nature of this effect is discussed and its potential value for the x-ray spectroscopy of light elements illustrated. (auth)

25994 APPARATUS FOR THE STUDY OF EJECTION OF AUGER ELECTRONS FROM SOLID SURFACES. Frank Propst and Edgar Luescher (Univ. of Illinois, Urbana). Rev. Sci. Instr., 34: 574-9(May 1963).

A stainless steel apparatus for the study of the ejection of electrons from solid surfaces is described. The bakeable vacuum system consists of three sections and is capable of maintaining pressure in the 10^{-10} mm Hg region. Each of the three sections is pumped via a liquid nitrogen trap by a mercury diffusion pump. Typical pressures under operating conditions are 10^{-9} mm Hg in the target section and 10^{-8} mm Hg in the ion-source section. The ion-lens system is described and a convenient method of construction of ion lenses is illustrated. A description of a simple analog computer that determines the yield and the energy distribution of the ejected electrons is given. (auth)

25995 THE INFRARED SPECTRA OF ORGANOPHOSPHORUS COMPOUNDS IN THE CsBr REGION. J. R. Ferraro, D. F. Peppard, and G. W. Mason (Argonne National Lab., Ill.). Spectrochim. Acta, 19: 811-17(May 1963).

The infrared absorption spectra of organophosphorus compounds of the type GOG'PO(OH), $(GO)_2PO(OH)$, $(GO)_2G'PO$, and $(GO)_3PO$ (in which G may be aryl, alkyl, mixed alkyl–aryl, or a substituted variant thereof) were investigated from 275 to 650 cm^{-1}. Absorption in the 600 cm^{-1} region appears to be associated with the P—Oφ group and absorption in the 530 cm^{-1} region with the Pφ group. (auth)

25996 ON THE INTERACTION OF QUANTIZED ELECTROMAGNETIC AND GRAVITATIONAL FIELDS. I. Piir. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 5, 41-53 (1957). (In Russian)

The problem of the interaction of quantized electromagnetic and gravitational fields is considered. By means of the S-matrix formalism cross sections for first and second order processes are calculated for scattering of photons and radiation of gravitons by photons in an external gravitational field, production of a graviton pair by annihilation of a photon pair, and second order photon scattering by photons. (auth)

25997 ON FORBIDDEN RANGES OF ENERGY FOR AN ELECTRON IN A ONE-DIMENSIONAL NON-PERIODIC POTENTIAL FIELD. K. Rebane. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 5, 72-84(1957). (In Russian)

Sufficient conditions for the existence of forbidden ranges of energy in the energy spectrum of an electron moving in a one-dimensional nonperiodic potential field are discussed. It is shown that the condition of Saxon and Hutner is not sufficient. On the basis of the sufficient conditions given forbidden ranges of energy are estimated for certain one-dimensional liquid models and the results are compared with those of Landauer and Helland. (auth)

25998 A RELATIVISTICALLY INVARIANT TREATMENT OF THE SELF-ACTION OF A FREE ELECTRON IN QUANTUM ELECTRODYNAMICS. Kh. Yiglane. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 5, 93-9(1957). (In Russian)

A relativistically invariant method is proposed for investigation of the self-action of a free electron in quantum electrodynamics. (auth)

25999 A TREATMENT OF THE SELF-ACTION OF A BOUND ELECTRON IN QUANTUM ELECTRODYNAMICS. Kh. Yiglane. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 5, 100-18(1957). (In Russian)

The problem of the self-action of a bound electron in quantum electrodynamics is considered. In order to remove divergence, the usual D-function is replaced by a modified function of propagation, that differs radically from the usual D-function only when virutal photons are present. The term of the self-action of the electron at all stages of computation remains covariant. In the case of a stationary external field the term of self-action is expressed by usual form. (auth)

26000 THE PROBLEM OF THE SELF-ACTION OF AN ELECTRON IN BOPP-PODOLKY'S ELECTRODYNAMICS. I. Kuuzik. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 5, 119-32(1957). (In Russian)

The electron self-action problem in Bopp-Podolsky's electrodynamics is considered by means of two different methods. The results do not totally remove divergence. (auth)

26001 AN INVESTIGATION OF THE STRUCTURE OF LUMINESCENCE CENTERS IN NaCl–Sn PHOSPHORS. R. I. Gindina and G. K. Vale. Tr. Inst. Fiz. i Astron., Akad. Nauk, Est. SSR, No. 21, 30-60(1962). (In Russian)

Spectral, polarization, and microscopic analyses of luminescence in NaCl(Sn) phosphors were carried out. Physical and chemical conditions for the creation of phosphorescence centers, the effect of plastic deformation, x irradiation, and treatment with uv radiation on the spectral characteristics of phosphors were investigated. Luminescence of NaCl(Sn) whiskers was compared with that of similar crystals grown from solutions and melts. It was concluded that Type I centers in NaCl(Sn) phosphors present Sn^{2+}-ions in the node of the crystal lattice beside the cation vacancies, the centers of Type II being more complex aggregations of Sn^{2+} and point or linear lattice defects. (auth)

26002 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY, 1963 ANNUAL MEETING, SALT LAKE CITY, JUNE 17-19, 1963. Malcolm D. Ferrier, ed. Trans. Am. Nucl. Soc., 6: No. 1, 1-208(June 1963).

Summaries of 237 papers are included; the title of each is listed in NSA. For the users convenience all titles have been listed in this subject category. Where other subject categories would be more appropriate, cross references have been used. Complete author and subject indexes have been prepared. In the event the complete papers are published later, they will be announced in NSA. (D.E.B.)

26003 BOUNDARY CONDITIONS FOR THE EVEN-ORDER SPHERICAL HARMONICS METHOD. John O. Mingle (Kansas State Univ., Manhattan). Trans. Am. Nucl. Soc., 6: 1(June 1963).

26004 NON-CELL CORRECTION TO THIN-CELL HOMOGENIZATION. N. R. Candelore and R. C. Gast (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 1-2(June 1963).

26005 BLACKNESS IN CYLINDRICAL FUEL LATTICES. A. Sauer (Allgemeine Elektricitats-Gesellschaft, Frankfurt am Main). Trans. Am. Nucl. Soc., 6: 2-3(June 1963).

26006 ON THE BEST METHOD FOR CHOOSING THE WEIGHTING FUNCTIONS IN THE METHOD OF WEIGHTED RESIDUALS. S. Kaplan (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 3-4(June 1963).

26007 SOLUTION OF DIFFUSION EQUATIONS IN RECTANGULAR CELLS. M. A. Mannan and P. F. Zweifel (Univ. of Michigan, Ann Arbor). Trans. Am. Nucl. Soc., 6: 4(June 1963).

26008 SYMMETRY PROPERTIES OF SOME EIGENFUNCTIONS OCCURRING IN REACTOR ANALYSIS. Mark Goldsmith (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 4-5(June 1963).

26009 ENHANCEMENT OF EXPERIMENTERS' FLUXES IN THE ARGONNE ADVANCED RESEARCH REACTOR (AARR). C. N. Kelber (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 5-6(June 1963).

26010 THEORY OF CORRELATIONS AND FLUCTUATIONS IN NEUTRON DISTRIBUTIONS. R. K. Osborn and S. Yip (Univ. of Michigan, Ann Arbor). Trans. Am. Nucl. Soc., 6: 6-7(June 1963).

26011 EXPLICIT FORMS AND RECURSION RELATIONS FOR THE QUANTITIES T^{n}_{LL}. E. M. Gelbard and D. R. Harris (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 8(June 1963).

26012 A STABLE AND NON-ITERATIVE SOLUTION TO THE DISCRETE ORDINATE EQUATIONS. E. Schmidt (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 8-9(June 1963).

26013 RECENT ADVANCES IN ONE- AND TWO-DIMENSIONAL MULTIGROUP DIFFUSION COMPUTATION. B. M. Segal and E. R. Volk (Atomic Power Development Associates, Inc., Detroit). Trans. Am. Nucl. Soc., 6: 9-10 (June 1963).

26014 NUMERICAL SOLUTION OF MULTI-GROUP EQUATIONS. K. F. Hansen and D. R. Edwards (Massachusetts Inst. of Tech., Cambridge). Trans. Am. Nucl. Soc., 6: 10(June 1963).

26015 ONE-DIMENSIONAL STUDIES PRELIMINARY TO TWO-DIMENSIONAL CALCULATIONS. R. J. LaBauve, B. M. Carmichael, and G. H. Best (Los Alamos Scientific Lab., N. Mex.). Trans. Am. Nucl. Soc., 6: 10-11(June 1963).

26016 TWO-DIMENSIONAL S_n CALCULATIONS FOR LAMPRE I. G. H. Best, B. M. Carmichael, and R. J. LeBauve (Los Alamos Scientific Lab., N. Mex.). Trans. Am. Nucl. Soc., 6: 11-12(June 1963).

26017 MOCA 2-A MULTIPURPOSE MONTE CARLO CODE FOR FAST-EFFECT CALCULATIONS. H. Rief (Euratom, Ispra, Italy). Trans. Am. Nucl. Soc., 6: 12-13 (June 1963).

26018 EFFECTS OF FUEL MOTION ON CRITICAL MASS IN A PLUTONIUM GASEOUS NUCLEAR ROCKET EMPLOYING VORTEX FLOW FOR FUEL CONTAINMENT. Thomas S. Lathem (United Aircraft Corp., East Hartford, Conn.). Trans. Am. Nucl. Soc., 6: 13(June 1963).

26019 A NEW APPROACH ON ENGINEERING HOT-CHANNEL AND HOT-SPOT FACTORS: STATISTICAL ANALYSIS. U. L. Businaro and G. P. Pozzi (FIAT, Turin). Trans. Am. Nucl. Soc., 6: 13-15(June 1963).

26020 A REVIEW OF THE METHODS FOR CALCULATING SPATIALLY DEPENDENT THERMAL-NEUTRON SPECTRA. Henry C. Honeck (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: 16(June 1963).

26021 THE MATHEMATICAL ASSISTANT: SYMBOLIC MANIPULATION VIA TIME-SHARED COMPUTER DISPLAY SYSTEMS. M. L. Minsky (Massachusetts Inst. of Tech., Cambridge). Trans. Am. Nucl. Soc., 6: 16(June 1963).

26022 MODIFIED P_3 APPROXIMATIONS TO THE NEUTRON-TRANSPORT EQUATION. Charles Dawson (Dept. of the Navy, Washington, D. C.). Trans. Am. Nucl. Soc., 6: 17(June 1963).

26023 THE VALIDITY OF THE TRANSPORT APPROXIMATION IN FAST-REACTOR CALCULATIONS. G. D. Joanou and A. Halim Kazi (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 17-18(June 1963).

26024 ANISOTROPIC SCATTERING IN THE TRANSPORT EQUATION: THE EFFECT OF SEVERAL APPROXIMATIONS ON THE INFINITE-MEDIUM DIFFUSION LENGTH. K. D. Lathrop (Los Alamos Scientific Lab., N. Mex.). Trans. Am. Nucl. Soc., 6: 18-19(June 1963).

26025 TRANSPORT-THEORY CALCULATIONS OF TEMPERATURE COEFFICIENTS IN HETEROGENEOUS REACTOR LATTICES. John E. Suich (Massachusetts Inst. of Tech., Cambridge) and Henry C. Honeck. Trans. Am. Nucl. Soc., 6: 19-20(June 1963).

26026 DIFFERENCE EQUATIONS IN NEUTRON-TRANSPORT THEORY. Bengt G. Carlson (Los Alamos Scientific Lab., N. Mex.). Trans. Am. Nucl. Soc., 6: 20-1(June 1963).

26027 TIME-DEPENDENT SOLUTION OF THE ONE-VELOCITY TRANSPORT EQUATION IN SLAB GEOMETRY. Robert L. Bowden, Jr. and Clayton D. Williams (Virginia Polytechnic Inst., Blacksburg). Trans. Am. Nucl. Soc., 6: 21(June 1963).

26028 MULTIPLE COLLISION DENSITIES FOR CALCULATING NEUTRON-DISTRIBUTION FUNCTIONS BY MONTE CARLO. H. J. Amster and W. K. Talley (Univ. of California, Berkeley). Trans. Am. Nucl. Soc., 6: 21-22 (June 1963).

26029 THE SPATIAL DEPENDENCE OF THERMAL-NEUTRON SPECTRA ACROSS A TEMPERATURE AND ABSORPTION DISCONTINUITY. J. R. Beyster, D. E. Parks, R. B. Walton, and N. F. Wikner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 23-4(June 1963).

26030 NEUTRON THERMALIZATION IN ZIRCONIUM HYDRIDE. G. K. Houghton, J. R. Beyster, J. C. Young, and G. D. Trimble (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 24-5(June 1963).

26031 THE DISCRETE ENERGY REPRESENTATION OF THE THERMALIZATION PROBLEM. P. B. Daitch and M. J. Ohanian (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Am. Nucl. Soc., 6: 25-6(June 1963).

26032 VELOCITY POLYNOMIALS IN NEUTRON THERMALIZATION. Charles S. Shapiro and Noel Corngold (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: 26(June 1963).

26033 THE EXACT SOLUTION OF THE VELOCITY-DEPENDENT MILNE PROBLEM USING A SIMPLE SCATTERING KERNEL. M. M. R. Williams (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: 27-8(June 1963).

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26240 INVESTIGATION OF d-d REACTIONS IN ALUMINUM SELF-TARGETS. Alfred Hofmann (Universität, Erlangen-Nuremberg). Z. Physik, 174: 57-67(1963). (In German)

The loading of aluminum with deuterium by bombardment with deuterons (to 100 kev) was investigated. The dependence of the neutron yields from the reaction $H^2(d,n)He^3$ + 3.26 Mev in this self-target on irradiation time, target temperature accelerator voltage, and current density was studied. The results were explained with the help of a diffusion representation. (tr-auth)

26241 BACKSCATTERING OF ELECTRONS IN ENERGY REGION FROM 60 TO 100 Kev. J. K. Bienlein and G. Schlosser (Universität, Erlangen, Ger.). Z. Physik, 174: 91-101(1963). (In German)

The layer-thickness dependence of the backscattering of electrons on Al, Ag, Sn, and Au was investigated for energies of 60, 75, and 100 kev. The scattering angle amounted to 115 to 160° opposite the primary beam, which struck perpendicularly to the foil. The following back-diffusion thicknesses of Au were found: at 60 kev, D = 3 ± 1 mg/cm^2; at 75 kev, D = 5 ± 1 mg/cm^2; and at 100 kev, D = 8 ± 1 mg/cm^2. The same values were obtained for Al. By integration, over the half-space, of the back-diffusion coefficients per solid angle the total back-diffusion coefficients (R_{tot}) were obtained. The following values were independent of the primary energy between 60 and 100 kev: for Al, R_{tot} = 0.14 ± 0.01; for Ag, R_{tot} = 0.38 ± 0.02; for Sn, R_{tot} = 0.42 ± 0.02; and for Au, R_{tot} = 0.48 ± 0.02. With a semiconductor detector, the spectra obtained for the backscattered electrons showed an increase of the probable energy loss at increasing scattering angles. For Au the average energy loss was smaller than for Al. (tr-auth)

26242 SUPERCONDUCTIVITY OF GALLIUM NITRIDES. N. E. Alekseevskii, G. V. Samsonov, and O. I. Shulishova (Inst. of Problems in Physics, Academy of Sciences, USSR and Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 44: 1413-15(Apr. 1963). (In Russian)

Superconductivity in prepared non-transient GaN and InN powder specimens was studied. Magnetic moments of GaN as a function of magnetic field at T = 3.32°K and the critical field as a function of temperature were extrapolated and the following parameters were found: T_c = 5.85°K, $(H_{c1})_{T0} \approx$ 725 gauss, $dH_{c1}/dT \approx$ 190 gauss/°K. For a field magnitude H_{c2}, in which the magnetic moment becomes zero the $dH_{c2} \approx$ 450 gauss/°K. No signs of superconductivity were disclosed in InN specimens at temperatures to 1.38°K. (R.V.J.)

26243 CONCERNING THE THEORY OF SHOCK WAVES IN RELATIVISTIC MAGNETIC HYDRODYNAMICS. R. V. Doich. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 1, 38-46 (Jan.-Feb. 1963). (In Russian)

The structure of weak shock waves was investigated by the use of equations applicable in relativistic magnetic hydrodynamics. The equations contain terms that take into account dissipative effects. A relationship was derived for the change of thermodynamic and electromagnetic quantities within the explosion. The dependence of the shock wave width on the dissipative coefficients and on the amount of density change was established. The influence of thermoelectric events on the structure of the shock wave was examined. It is shown that following thermoelectric events a longitudinal electric field is set up inside the explosion. While this particular event is nonrelativistic there is another event induced by the thermoelectric events which is clearly relativistic. It arises when the magnetic lines of force collide against a surface in which are located magnetic lines of force normal to the explosion. The dependence of the shock wave velocity is given for a particular change in pressure. (TTT)

26244 MEASUREMENT OF SPIN POLARIZATION OF ELECTRON BEAMS. W. Raith. Thesis, Berlin, Technische Universität, 1962. 77p. $2.00.

A polarization detector using Mott scattering is described. This detector was calibrated with a double-scattering experiment. The detector can be used for the determination of very small polarization degrees of the order of 4×10^{-3}. For an accurate measurement of polarization in several minutes a primary current of 10^{-10} amp is needed. The spin polarization of unpolarized electrons after transmission through thin magnetized iron foils is studied. The results indicate that the polarization cross section for 60 kev electrons is smaller than 10^{-20} cm^2. The polarization cross section is the sum of the spin exchange cross section and the spin-dependent fraction of the total scattering cross section. The last fraction was calculated using the theory of Möller scattering. The theoretical value is smaller than the upper limit of the polarization cross section by more than one order of magnitude. (Gmelin Inst.)

26245 PRODUCTION OF STRONTIUM-90 THERMAL POWER SOURCES. A. Schneider, J. L. Bloom, and J. S. Cochran (Martin-Marietta Corp. Aerospace Div., Baltimore). IAEA Preprint No. CN-14/22. 31p. (TID-18761)

To be published in IAEA Proceedings of the Conference on the Application of Large Radiation Sources in Industry, held in Salzburg, Austria, May 27–31, 1963.

One of the most attractive areas for utilization of large quantities of waste fission products was demonstrated to be in the field of direct conversion power supplies for remote locations. Sr^{90} is being given the greatest exploitation because of its availability, nuclear properties, and the relative ease with which it can be fabricated into compact heat sources. Sr^{90}-fueled generators are being used to power automatic weather stations and navigational aids, and consideration is being given to the use of Sr^{90} as a power source for space vehicles. Evaluation of several potentially useful strontium compounds led to the selection of the titanate as exhibiting over-all properties most desirable for this purpose. Sr^{90}, separated from crude fission product streams and purified to the requisite degree, is shipped in the form of the carbonate to a hot-cell facility, where it is converted to titanate pellets. This process is an adaption to remote operation of conventional chemical and ceramic techniques. The pellets are encapsulated in Hastelloy C containers for use in thermoelectric power supplies. Unusual operational problems are encountered because the large quantities of Sr^{90} handled (potentially millions of curies per year) represent formidable radiation and contamination hazards. Details of the facility, equipment, process, and safety criteria are given. The operational experience gained during the recent processing of the first 250,000 curies of Sr^{90} into fuel for a SNAP-7 generator is described. Encapsulation, calorimetry decontamination, and waste-disposal procedures are also outlined. (auth)

26246 ENERGY AND ANGULAR DISTRIBUTION OF SECONDARY ELECTRONS PRODUCED BY 100 kev PROTONS IN HYDROGEN AND 50-150 Kev PROTONS IN HE-

LIUM. Millard Eugene Rudd. Thesis, Lincoln, Neb., Univ. of Nebraska, 1962. 111p.

Differential cross sections for ejection of secondary electrons of various energies at various angles were measured for H gas bombarded by 100 kev protons and He gas bombarded by 50 to 150 kev protons. The range of angles investigated was 10 to 160° and the range of electron energies was from 1 to 500 ev. Electron energies were analyzed by a 127° electrostatic analyzer. An electron multiplier was used to count the individual electrons. To determine the efficiency of the counter, absolute measurements of cross sections differential in angle only were made at 10, 30, and 50° by collecting the electrons in a Faraday cup and measuring the resulting current. Comparison with the integral of the differential cross sections made possible the calculation of absolute values of all cross sections. As a function of electron energy, all cross sections decrease monotonically above 2.5 ev and are uncertain below this value. As a function of angle, the cross sections are largest at the smallest angle, decreasing monotonically up to about 90° and staying relatively constant above 90°. Agreement with other experimental and theoretical results is discussed. (Dissertation Abstr.)

26247 STATISTICAL MECHANICS OF THE ELECTRON-PHOTON GAS. Toshio Nakayama. Thesis, Boulder, Colo., Univ. of Colorado, 1962. 166p.

A system of charged particles in a radiation field in thermodynamic equilibrium is investigated by means of the linked-cluster expansion method developed by Bloch and DeDominicis. Results are given for the high temperature-low density approximation. Analysis of the lower order perturbation expansion terms shows that the lowest order correction to the perfect gas law is of order e^2, where e is the particle charge. In the high temperature-low density approximation, two types (I and II) of electron-photon ring diagrams are found to be relevant in addition to the ordinary Coulomb ring diagrams. The electron-photon ring diagrams of type II, however, give a divergent result for small momentum transfer between electrons and photons. It is shown that this divergence may be removed by the use of dressed photon propagators corresponding to electron-"bubble"-type self-energy diagrams. Then the electron-photon ring diagrams give a finite contribution to the thermodynamic potential. The dressed photon propagator leads to a new photon density function (also obtained by Osborn and Klevans) and furthermore gives a clear physical picture of the interaction. Finally it is shown that there is no correction to the thermodynamic potential of order e^4 at high temperature and low densities. Fifth-order corrections to the thermodynamic potential, which give radiative corrections to the Coulomb ring diagrams, are investigated. The radiative corrections to the Coulomb ring diagrams using free photon propagators lead to divergent terms, which, however, cancel each other in this approximation. These divergences are also removed by use of the dressed photon propagator. (Dissertation Abstr.)

26248 ELECTRICALLY INDUCED NUCLEAR QUADRUPOLE SPIN TRANSITIONS IN A GaAs SINGLE CRYSTAL. William Luther Pierce. Thesis, Boulder, Colo., Univ. of Colorado, 1962. 59p.

An investigation has been made of the direct electrical induction of nuclear-quadrupole-spin transitions in a gallium-arsenide single crystal. Theoretical expressions are derived for the equilibrium nuclear magnetization in a static magnetic field of a collection of nuclear spins imbedded in a crystalline lattice. The combined influence of externally induced electric field gradients and thermal spin-lattice interactions for various relative orientations of the static magnetic field, the crystalline symmetry axes, and the external, oscillatory, electric field is considered. The interaction between the crystal and the external electric field is described by a one-parameter, third-rank tensor. The theoretical predictions were tested by using pulsed NMR techniques to sample the equilibrium magnetization in the crystal at 77°K under the influence of a uniform, externally applied, r-f, electric field. A detailed description of the experimental apparatus is given. The quadrupolar line widths and spin-lattice relaxation times were experimentally determined for Ga^{69}, Ga^{71}, and As^{75}. The dependence of the quadrupolar saturation on both the electric field amplitude and the crystal orientation was measured. The angular dependence of the saturation was found to be in good agreement with the theory. The value of the parameter describing the interaction of the GaAs crystal with the electric field was measured. An interesting angular dependence of the amplitude and shape of the pulsed nuclear induction decay signal, with no applied electric field, was discovered. (Dissertation Abstr.)

26249 THE TEMPERATURE DEPENDENCE OF THE NUCLEAR QUADRUPOLE RESONANCE IN SOME MOLECULAR SOLIDS. Charles Bonner Richardson. Thesis, Pittsburgh, Univ. of Pittsburgh, 1962. 117p.

The nuclear quadrupole resonance of Cl and its Zeeman effect were observed in the following compounds over the range of temperature indicated: paradichlorobenzene, 195°K to 304°K; 1,2,3,4 tetrachlorobenzene, 78°K to 291°K; and chloranil, 78°K to 374°K. The temperature dependence of the nuclear-quadrupole-resonance (nqr) frequencies and the field gradient asymmetries were used with the Bayer theory of the dependence to deduce the rigid body libration amplitudes in the latter 2 compounds. A structural change in chloranil at a temperature near 100°K was detected and carefully investigated by the nqr. The change appears to be an order-disorder transition. The evidence supporting this conclusion is presented and discussed at length. The nqr in dichloroethylene and molecular Cl was observed over a wide temperature range in an effort to detect "free rotation." In the former, signal "fadeout" occurred about 100°C below the melting point, and did not appear at a higher temperature. In molecular Cl the signal was visible up to the melting point, indicating no disordering. An unexplained increase in signal strength, together with a decrease in the nqr temperature dependence, occurred about 6° below the melting point. A variable-temperature nqr Zeeman recording spectrometer, in which resonance is detected by slowly rotating a single crystal sample in a constant magnetic field, recording the relative amount of radiofrequency energy absorbed by the sample as a function of orientation, is described. (Dissertation Abstr.)

26250 PROCEEDINGS OF THE LUNAR AND PLANETARY EXPLORATION COLLOQUIUM HELD AT SANTA MONICA, CALIFORNIA, 23 AND 24 MAY 1962. E. M. Fallone, ed. Downey, California, North American Aviation, Inc., 1962. 176p.

Papers were presented on various aspects of lunar and planetary exploration with emphasis on experiments that can be performed in the laboratory and those designed and developed for space flight. The topics discussed included the study of extraterrestrial life, radiation environments in space, the importance of manned lunar exploration, biological effects of radiation, and zero-gravity environment. Separate abstracts were prepared for 7 of the 16 papers presented. (C.E.S.)

26251 VAN DER WAALS FORCES IN MANY-BODY SYSTEMS. Robert Yaris. Thesis, Seattle, Univ. of Washington, 1962. 78p.

In order to understand more fully the operation, in a many-body environment, of the familiar dispersion type attractive forces, theoretical investigations were conducted on three many-body systems. In all cases a variational form of perturbation theory was used, rather than the more usual Schroedinger form of perturbation theory. There is a quantum mechanical treatment of the physical adsorption of isotopic species. The seemingly anomalous experimental results of Constabaris, Sams, and Halsey, that D_2 interacts more strongly with a carbon surface than H_2 but CH_4 interacts more strongly than CD_4, is explained in terms of two competing effects: the quantum statistical mass effect on the vibrational energies normal to the surface, and the quantum mechanical effect of isotopic substitution on the dispersion energy. There is a treatment of the effect of three-body dispersion forces on physically adsorbed monolayers. In this treatment a variational derivation of the three-body dispersion energy is presented and applied to the problem of two molecules interacting with a surface. The resulting equation, containing only experimentally measurable quantities, was compared with adsorption data of Ar, Xe, and CCl_4 adsorbed on P33 graphitized carbon black treated as a two-dimensional gas. It was concluded that the experimental data can be adequately explained by renormalizing the gas parameters for three-body dispersion effects, and that it is not necessary to postulate an electrostatic surface field. The polarizability change in liquids due to many-body interactions is considered. Approximate quantum mechanical expressions were derived for the change of polarizability for a spherically symmetric liquid. These expressions are evaluated using Linder's continuum model for the liquid and Slater Type Orbital wave functions. It is shown that the change in polarizability is approximately $(3/8)g\alpha^2$, where α is the unperturbed, isolated molecule, polarizability and g is a parameter which depends on the dielectric constant and molar volume of the liquid. The predicted increase in the polarizability due to many-body interactions is less than 7% for all molecules studied. (Dissertation Abstr. 23: May 1963)

26252 SUPERCONDUCTIVITY. E. A. Lynton. Methuen's Monographs on Physical Subjects. London, Methuen & Co. Ltd., 1962. 184p.

A book is presented as a descriptive introduction to superconductivity. An outline is given of the thermodynamic and static electromagnetic behavior of idealized bulk superconductors. The aspects of superconductors which lead to the nonlocal theories of Pippard and Ginzburg-Landau are discussed. The characteristics leading to the theory of Bardeen, Cooper, and Schrieffer are also described. Finally, superconducting alloys, compounds, and devices are considered. A bibliography of more than 330 references is included. (D.L.C.)

26253 SERVOSYSTEM FOR REGULATING MAGNETIC FIELDS. Sidney Arthur Stuart (to United Kingdom Atomic Energy Authority). U. S. Patent 3,089,068. May 7, 1963. Priority date Nov. 18, 1958, Great Britain.

An apparatus is patented, which can stabilize an electromagnetic field with an accuracy of the order of one part in 10^5. The apparatus consists of a d-c current coil suspended in the magnetic field to be regulated. Also in the field and magnetically coupled to the suspended coil is an oscillator coil. A change in the magnetic field strength causes an angular movement of the suspended coil, which changes the value of the reflected load in the oscillator coil causing a phase shift in the coil. A phase comparator compares the phase of the coil and the oscillator supplying the coil. The output of the phase comparator is proportional to the difference between the phases and actuates a servosystem, which adjusts the current generating the magnetic field until the phase shift is zero. The strength of the magnetic field is thereby restored to its original value. (M.P.G.)

26254 RESONATOR PARTICLE SEPARATOR. J. P. Blewett and J. D. Kiesling (to U. S. Atomic Energy Commission). U. S. Patent 3,093,733. June 11, 1963.

A wave-guide resonator structure is designed for use in separating particles of equal momentum but differing in mass, having energies exceeding one billion electron volts. The particles referred to are those of sub-atomic size and are generally produced as a result of the bombardment of a target by a beam such as protons produced in a high energy accelerator. In the resonator a travelling electric wave is produced which travels at the same rate of speed as the unwanted particle which is thus deflected continuously over the length of the resonator. The wanted particle is slightly out of phase with the travelling wave so that over the whole length of the resonator it has a net deflection of substantially zero. The travelling wave is established in a wave guide of rectangular cross section in which stubs are provided to store magnetic wave energy leaving the electric wave energy in the main structure to obtain the desired travelling wave and deflection. The stubs are of such shape and spacing to establish a critical mathematical relationship. (AEC)

Astrophysics and Cosmology

Refer also to abstracts 25449 and 25466.

26255 A MAGNETOHYDRODYNAMIC EXPLANATION OF THE EXISTENCE OF THE TERRESTRIAL MAGNETIC FIELD AND OF THE GENERAL MAGNETIC FIELD OF STARS. [PART] I. Cataldo Agostinelli. Atti Acad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat., (8), 32: 593-600(May 1962). (In Italian)

The existence and permanence of the terrestrial magnetic field, induced by an eddy motion of the internal liquid mass, and the existence of a general magnetic field in stars, generated by the rotation of an internal almost compact nucleus compressed from the fluid surrounding it and exposed to self gravitation, were investigated with MHD methods. It was assumed that the magnetic field generated by the ellipsoidal fluid mass has, at the surface, a normal component equal to that determining a magnetic dipole near the center. It was also assumed that the fluid mass has, in addition to the internal eddy motion, a transverse motion. The dipole potential of an ellipsoidal fluid mass with reference to elliptical coordinates was expressed. The normal component at the surface was calculated. (J.S.R.)

26256 A MAGNETOHYDRODYNAMIC EXPLANATION OF THE EXISTENCE OF THE TERRESTRIAL MAGNETIC FIELD AND OF THE GENERAL MAGNETIC FIELD OF STARS. [PART] II. Cataldo Agostinelli. Atti Acad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat. (8), 32: 801-7(June 1962). (In Italian)

In a continuation and completion of the MHD study of the terrestrial and stellar magnetic fields, it was assumed

that the conduction current and the eddy current were functions of time only. On that basis it was shown that the problem is solved by squaring and that, therefore, an eddying MHD motion exists inside the ellipsoid. This motion will generate a magnetic field whose normal component at the surface assumes the same value as that determining a magnetic dipole near the center. The case in which the ellipsoid is reduced to a sphere in which the eddy is constant with respect to time and the internal motion of the fluid nucleus is reduced to a uniform rigid rotation is considered. (J.S.R.)

26257 ROCKET SPECTROSCOPY. S. N. Ghosh and Sharda Nand (Univ. of Allahabad, India). Contemp. Phys., 4: 241-55(Apr. 1963).

Ultraviolet and x-ray photon detectors, ion chambers, and thermoluminescent phosphors used in obtaining solar spectra in the wavelength range 3000 Å to x-ray are described. Spectra obtained in parts of this range are displayed, and new lines noted in them are pointed out. Intensities and energies of lines are also examined. Determination of the atmospheric distribution of N_2 and NO and of the sun's temperature from analysis of such data is discussed, and the manner in which solar radiation of various wavelengths could account for ionization of the D, E, and F-layers of the atmosphere is demonstrated. 26 references. (D.C.W.)

26258 THE ORIGIN OF THE SOLAR SYSTEM. W. H. McCrea (London Univ.). Contemp. Phys., 4: 278-90(Apr. 1963).

The problem of accounting for a solar system in which about 0.1% of the mass has about 99% of the angular momentum and in which a mass of hydrogen greater than the remaining planet mass apparently left the planets is examined. Previous theories for the origin of the solar system are reviewed; recent relevant developments in astronomy are described; and current theories based on formation from a solar nebula, from condensation of planets, from planetesimals, and from turbulent matter are briefly presented. Origin of satellites is also mentioned. (D.C.W.)

26259 OBSERVATIONS OF SOLAR X-RAY EMISSION IN THE 8 TO 20 Å BAND. L. W. Acton, T. A. Chubb, R. W. Kreplin, and J. F. Meekins (Naval Research Lab., Washington, D. C.). J. Geophys. Res., 68: 3335-44(June 1, 1963).

One hundred-one observations of the solar x-ray flux in the 8 to 20 Å band are reported. These observations are made by the Solar Radiation 3 satellite from June 29 to November 26, 1961. The fluxes range above 0.4 erg cm^{-2} sec^{-1}, during a 3^+ limb flare, and below the limit of detectability, 0.002 erg cm^{-2} sec^{-1}. The intensity of this radiation is correlated with general solar activity and is greatly enhanced during some flares. The intensity is observed to change by a factor of 2 without any apparent change in solar activity. X-ray enhancements may persist for hours after the end of large flares. Comparison of sudden ionospheric disturbances and the x-ray enhancements indicates that the spectrum of the x radiation differs from one flare to the next and with time during a given flare event. (auth)

26260 HIGH HYDROGEN LINES IN EARLY-TYPE STARS. Leo Houziaux (Université, Liège). J. Quant. Spectry. Radiative Transfer, 3: 167-70(Apr.-June 1963).

The spectrum of high hydrogen lines was computed for the luminosity classification of B-type stars with emission in the early Balmer lines. The results show a serious blending. The profile distortion due to rapid axial rotation was calculated. The fraction of energy absorbed by hydrogen lines and the corresponding temperature distribution correction are given. (D.L.C.)

26261 POSSIBLE APPLICATIONS OF THE MASS-ENERGY CYCLE ON A MICRO- AND MACRO-SCOPIC SCALE IN THE UNIVERSE. John L. Hughes (University Coll., Banjor, North Wales). Nature, 198: 772-3(May 25, 1963).

The properties of the cyclic model of the universe are compared with other cosmological models. The cyclic behavior of the universe is discussed. It is pointed out that the cyclic model is the only one intimately concerned with both the micro and macro worlds. (C.H.)

26262 MASSIVE HOMOGENEOUS HELIUM-STAR MODELS. M. Cimino, P. Giannone, M. A. Giannuzzi, A. Masani, and N. Virgopia (CNR, Rome and CONARM, Rome). Nuovo Cimento (10), 28: 621-38(May 1, 1963). (In English)

Homogeneous massive helium-star models are calculated considering the radiation pressure in the whole star. Electron scattering is assumed for the opacity, and for energy generation the 3α reactions are assumed. Radii are about solar radius, effective temperatures are high and values of central density and temperature exclude electronic degeneracy. When the mass increases the models denote a progressive increase of the radius and of the mass of the convective adiabatic equilibrium zone, until the total mass of the star is identified with the mass of the core, the model reducing itself thus to a totally convective model. Integration tables given can be used for all the homogeneous models with any chemical composition and with any energy generation law, provided the opacity is due to electron scattering and the central radiative pressure ranges between 0.1 and 0.8 times the total central pressure. (auth)

26263 ENERGY RELEASE IN SOLAR FLARES. M. A. Ellison (Dublin Inst. for Advanced Studies). Quart. J. Roy. Astron. Soc., 4: 62-73(Mar. 1963).

The flare mechanism is regarded as a process in which energy that was slowly stored up in a chromospheric magnetic field is suddenly released by instability in the plasma. The Hα flash phase of a 3^+ flare has a duration of 2–3 minutes: the main release of energy takes place in this, or it may even be a shorter period of time. A new estimate of the total energy radiated in optical wavelengths is found to be $\sim 10^{32}$ ergs. From the known dimensions of the flare, this implies an energy liberation of at least 10^3 ergs/cm^3, or about one thousand times the thermal energy density of an equivalent non-flare region. If the energy comes from a magnetic field, then a field of $\sim$150 gauss must be destroyed. Changes in the Hα striation patterns in the vicinity of great flares are described and these are considered to arise from the destruction or redistribution of the chromospheric magnetic fields within the region outlined by the visible flare nimbus. Homologous flares are those that recur successively in the same active region according to an identical pattern. They provide evidence that the energy is slowly stored up and is released repetitively: the storage interval is $\sim$10 times the flare duration. Storage is assumed to take place in a magnetic field region that can build itself up repeatedly into the same isogauss pattern before the catastrophic release occurs. (auth)

26264 A TREATISE ON RADIATIVE TRANSFER. V. V. Sobolev. Translated by S. I. Gaposchklin. Princeton, N. J., D. Van Nostrand Co., Inc., 1963. 328p. $9.75.

Several new methods in the theory of radiative transfer

and their application to astrophysical problems were presented. Special attention was given to diffuse radiation with redistribution in frequency and to nonstationary processes of radiative transfer. Problems of radiative transfer in atmospheres of stars and planets were formulated from theory. Determination of emergent radiation intensity and polarization and the probability of quantum exit were included. Luminescence of a medium with radiation-reflecting surface and radiative transfer and with sufficient general assumptions with respect to its optical properties was considered with respect to planetary atmospheres. (C.E.S.)

26265 A METHOD OF DETERMINATION OF IONOSPHERIC ELECTRON DENSITY PROFILES FROM FARADAY ROTATION OF SATELLITE BORNE RADIO SIGNALS. Victor Hugo Gonzalez. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 59p.

When a radio wave propagates in a magneto-ionic medium under quasi-longitudinal conditions the plane of polarization rotates along the ray. This effect is known as the Faraday effect. The rotation of the plane of polarization depends on the physical characteristics of the medium along the path, such as magnetic field and electron density. The Faraday effect is one of the effects observed in the reception of radio signals from the artificial satellites, when the rays traverse the ionosphere in the presence of the earth's magnetic field. The observed phenomenon is a regular fading in the amplitude of the received signal which is due to the variation of the number of rotations of the polarization plane between satellite and station when the satellite moves across the sky. Detailed analyses were made of Faraday rotation records received at a ground station from a transmitting satellite. A set of parameters of a Chapman ionosphere model was assumed and the Faraday effect corresponding to a given satellite passage was calculated by means of an electronic computer using the ray tracing technique. The calculated result was compared with the experimental observations to generate a new set of parameters. The whole calculations were then repeated with the new ionosphere until the differences between the calculated and experimental values were minimized. It was found that in most cases a second order formula is much simpler to use and with almost equal satisfaction. The method was applied to an actual satellite amplitude record in 20 mc/s. It was found that the method did not yield as accurate a solution as hoped for. The phenomenon of one hop propagation when the satellite moves below the height of maximum electron density and the occurrences of the minima and maxima in the number of Faraday rotations between satellite and station were also examined. (TCO)

Cosmic Radiation

Refer also to abstract 24759.

26266 (AFSWC-TDR-62-133) EXPERIMENTAL TESTS FOR THE ACCELERATION OF TRAPPED PARTICLES. Richard L. Kaufmann (Air Force Special Weapons Center, Kirtland AFB, N. Mex.). Jan. 1963. 41p. (AD-297083)

Mechanisms that could result in the acceleration of charged particles within the magnetosphere are discussed in terms of the responses expected from experimental instruments as they pass through acceleration regions. A series of experimental tests is outlined that can determine if acceleration of trapped particles is important. The mechanisms discussed include Fermi acceleration, which can accelerate protons to tens or hundreds of kilovolts and can increase the energy of trapped electrons several hundredfold before they are lost in the dense atmosphere. A change in the intensity of the solar wind or in the strength of a ring current can change the energy of trapped particles by the betatron mechanism. Electrons can be accelerated to kilovolt energies by the setting up of plasma oscillations, by acceleration within moving clouds or by intrusions of solar plasma. Finally, particles may be accelerated to energies of 10 kilovolts or more in the vicinity of neutral lines. (auth)

26267 (NRL-5896) THE PRIMARY COSMIC RADIATION. M. M. Shapiro (Naval Research Lab., Washington, D. C. and Weizmann Inst. of Science, Rehovoth, Israel). Dec. 3, 1962. 9p. (AD-404746)

Some salient features of the cosmic radiation incident upon the earth are given, and implications of the Li–Be–B anomaly and the helium isotope abundances are discussed. The abundance ratio of cosmic-ray hydrogen to helium is similar to that for the thermal abundances in the sun and nearby stars. The other nuclei, particularly Li, Be, and B, are overabundant relative to hydrogen. Lower limits of cosmic-ray-particle flux and density for total energies exceeding 1.7×10^9 ev per nucleon are 0.28 particle/cm^2-sec-sterad and 1.2×10^{-10}/cm^3, respectively. The energy density is comparable to that of starlight. Over a wide range of energies, the energy spectrum conforms to a power law in W, the total energy per nucleon: the integral directional intensity varies as $W^{-1.5}$. Above 10^{14} ev the spectrum appears steeper, but its exact shape is as yet uncertain. The largest air shower reported came from a particle of an estimated 6×10^{19} ev. For a galactic magnetic field of 3×10^{-6} gauss, such particles would escape from the galaxy. Measurements indicate that the cosmic-ray abundance of Li, Be, and B at kinetic energies above 1.5×10^9 ev/nucleon is 2×10^5 times their general abundance. An assumption that this overabundance arises from the breakup of heavier nuclei permits estimates of the amount of interstellar hydrogen traversed, one estimate being 2.5 g/cm^2. The relative abundances of the helium isotopes are being investigated as a further means of calculating cosmic-ray path lengths. (auth)

26268 (PAN-388/VI) TWO-CENTER MODEL OF MESON PRODUCTION. J. Gierula (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1963. 28p.

The multiple meson production is described by the two-center model as an isotropic emission of mesons from centers moving with velocity that is neither the velocity of nucleons escaping the collision nor the velocity of the center-of-mass system of colliding nucleons. There is evidence of the formation of two or, sometimes, of one such center called fire-ball. This evidence is based on a large statistics of observations of transverse momenta and of the shape of logtan θ_L distributions in cosmic ray jets. Both of these quantities are Lorentz-invariant or nearly invariant and therefore can be safely measured in the laboratory frame of reference. (auth)

26269 (PAN-398/VI) MESON PRODUCTION IN THE CENTRAL COLLISIONS OF HEAVY PRIMARIES OF THE COSMIC RADIATION. K. Rybicki (Polish Academy of Sciences. Inst. of Nuclear Research, Krakow). Feb. 1963. 32p.

Twenty one central nucleus-nucleus collisions of heavy ($Z \geq 3$) primaries with nuclei of either the photographic emulsion or lead with energies $E \simeq 100$ Bev/nucleon were

studied. Total number of minimum tracks in the whole sample was 2564. Among them an extra high multiplicity event of the type 10 + 518 Ca was analysed. Twenty six secondary jets were found and measured, the relative scattering measurements were performed on 31 tracks. It was shown that the process of destruction of the incident nucleus in the central collisions is different from the usual evaporation. In these collisions the main part of the incident nucleons interacts. After interaction they are collimated at the small angles conserving about 40% of the primary energy. Meson production in the central collisions is not in disagreement with assumption of superposition of nucleon-nucleon collisions. (auth)

26270 THE DEGRADATION OF STELLAR AND COSMIC NEUTRINOS. V. M. Kharitonov. Dokl. Akad. Nauk SSSR, 150: 75-6(Mar. 1, 1963). (In Russian)

A previous study showed that neutrinos and antineutrinos are not absorbed by any known interaction. Thus, a continuous accumulation of neutrinos takes place. It is assumed that the energy flux of the original fast neutrinos has decreased by a factor k due to the Doppler shift (a particle with zero rest mass "ages", while a heavy particle with a rest mass not equal to zero remains "young".). The value of k for a neutrino is estimated to be $\sim 3 \times 10^4$ to 3×10^6. If the initial energy of the original neutrinos is assumed to be $\sim 10^9$ ev, the energy of the "relic" neutrinos of the present is $\sim 10^9/k = 3 \times 10^4$ to 300 ev. It is estimated that the neutrino flux is $\sim 10^{10}$ to 10^{12} neutrinos/cm^{-2}/sec^{-1}. The equilibrium energy flux of neutrinos emitted by the stars is estimated to be $\sim 10^{-6}$ to 10^{-5} Mev/cm^3 at an original neutrino energy of 1 to 3 Mev. The present energy of the neutrinos from the stars is ~1 to 100 ev. The present energy of neutrinos generated by cosmic rays is $\sim 10^2$ to 10^4 ev, and the equilibrium energy flux of the neutrinos obtained from cosmic rays is $\sim 2 \times 10^{-2}$ to 10^{-4} Mev/cm^3. These fluxes are many orders of magnitude greater than the neutrino flux from the sun. If it is assumed that the energy density of the neutrinos is equal to the density of heavy matter in the universe, the maximum energy of these neutrinos will be $\sim 10^{-2}$ ev, and the flux will be $\sim 1.5 \times 10^{19}$ particles/cm^{-2}/sec^{-1}. (TTT)

26271 IONOSPHERIC ABSORPTION OF COSMIC RADIO NOISE AT MAGNETICALLY CONJUGATE AURORAL ZONE STATIONS. Harold Leinbach and Roy P. Basler (Univ. of Alaska, College). J. Geophys. Res., 68: 3375-82 (June 1, 1963).

Riometer records of cosmic noise absorption obtained at Macquarie Island in the South Pacific and from several stations in the magnetically conjugate area in Alaska demonstrate a high correlation of auroral zone absorption events in the northern and southern hemispheres. Not only the periods of absorption, but also the magnitudes and structure of the events, are found to be closely, but not exactly, related in the two hemispheres. Both statistical studies and specific absorption events are discussed. The results are sufficient to demonstrate that there is a magnetically conjugate area of narrower dimension in latitude than in longitude. The results are not adequate to indicate whether the occasional breakdown of conjugacy is observed because: the riometers are not located at the actual conjugate points; the disturbance phenomena are sometimes nonsymmetrical between the two hemispheres; or the conjugate points are nonstationary. (auth)

26272 THE EFFECT OF QUASI-STATIC ELECTRIC FIELDS ON VAN ALLEN PARTICLES. J. W. Dungey (Pennsylvania State Univ., University Park). J. Geophys. Res., 68: 3540-1(June 1, 1963).

Assuming the existence of an electric field that extends into the outer shells of the magnetosphere, the motion of positively and negatively charged particles in the Van Allen belts is studied. The mirror points of these trapped particles are found as functions of energy, geomagnetic colatitude, geomagnetic field, and geo-electric field. The variation of mirror point with height is found, and is correlated with auroral storm characteristics. (T.F.H.)

26273 OBSERVATIONS ON EXTREMELY-HIGH ENERGY NUCLEAR EVENTS WITH EMULSION CHAMBERS EXPOSED ON MT. CHACALTAYA. PART I. C. M. G. Lattes, C. Q. Orsini, I. G. Pacca, M. T. Da Cruz, E. Okuno, Y. Fujimoto, and K. Yokoi (Universidade, São Paulo, Brazil). Nuovo Cimento (10), 28: 614-20(May 1, 1963). (In English)

A series of experiments to detect high-energy γ rays were carried out by means of emulsion chambers of area several square meters, exposed to cosmic rays for several months at altitude 5200 m. The features of nuclear interactions caused by extremely high-energy nucleons ($E_0 \geq 10^{15}$ ev) were observed. The result obtained by the first small test chamber is presented: there is no difficulty of fading and chemical background in the nuclear emulsions and x-ray films; cosmic ray background is sufficiently low, allowing γ-ray showers of energy greater than 10^{12} ev to be detected with 100% efficiency; 11 γ rays of energy equal to or greater than 1.5×10^{12} ev are observed. Nuclear absorption mean free path in air of (145 ± 30) g/cm^2 is obtained by a comparison of the γ-ray flux value at altitude 2700 m. A brief account of the experiments now going on is also given. (auth)

26274 GAMMA RAYS AT HIGH ALTITUDES. E. M. Hafner, M. F. Kaplon, J. G. Duthie (Univ. of Rochester, N. Y.), and G. G. Fazio. Phys. Rev. Letters, 10: 364-8 (Apr. 15, 1963).

The technique used to obtain data on charged particles and gamma rays is described along with corrections for changes in latitude during the two flights. Models that permit comparison of data obtained in different geometries are discussed. Analysis gives values of 0.0709 ± 0.0005, 0.0092 ± 0.0005, and 0.0017 ± 0.0001/cm^2-sec-sr for the charged particle, primary γ, and secondary γ fluxes, respectively. A more detailed analysis gives a primary γ flux of 0.0054 ± 0.0007 γ/cm^2-sec-sr. (D.C.W.)

26275 RECOIL PHOTONS FROM SCATTERING OF STARLIGHT BY RELATIVISTIC ELECTRONS. J. E. Felten and P. Morrison (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 10: 453-7(May 15, 1963).

Collisions between electrons that are known to produce nonthermal radio noise and the photons of starlight are considered as a source for the cosmic production of high-energy photons. The photon flux due to such collisions is calculated and compared with recent observations on photon flux in space. Simple models of electron distribution in space are considered and the corresponding photon fluxes are calculated. (C.E.S.)

26276 COSMIC PHYSICS. G. A. Skuridin. Priroda, No. 1, 3-15(1963). (In Russian)

Data are presented from measurements of the density, pressure, and composition of the upper atmosphere. The scheme of the earth's radiation belts, the distribution and concentration of charged particles in geocorona, and interplanetary plasma distributions are discussed. Short wave solar emissions and magnetic fields of the Earth and Moon are also discussed. (R.V.J.)

26277 MESONS STOPPED UNDERGROUND. A. M. Short (College of Advanced Tech., Birmingham, Eng.). Proc. Phys. Soc. (London), 81: 841-5(May 1, 1963).

Nuclear emulsions were exposed at a depth of 58 mwe underground to study stopped mesons, the rates for muons and pions being $(73 \pm 3)10^{-3}$ and $(2.7 \pm 0.6)10^{-3}$ cm^{-3} day^{-1}, respectively. The positive-negative ratio for the numbers of stopped muons is 1.1 ± 0.2, and the negative-positive ratio for stopped pions is 2.3 ± 0.9. The data on the stopped muons are consistent with the momentum spectrum of the cosmic ray muons at sea level. The pion data are not inconsistent with a mechanism of muon-nucleus interaction through the Coulomb field, but imply that pions are also produced by neutron secondaries from muon interactions. (auth)

26278 THE LATERAL DENSITY DISTRIBUTION OF ELECTRONS NEAR THE CORE OF EXTENSIVE AIR SHOWERS. Martin Harvey LaPointe, Jr. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1962. 153p.

An array of 27 large, electron-pulse ionization chambers was used to study the density structure, near the core, of cosmic ray air showers at 300 meters altitude. Single cored events, in which the distribution near the axis varied widely, were analyzed. Expressed as a power of the radial distance, events were found which were as peaked as $(r/R_0)^{-1.2}$ and as flat as $(r/R_0)^{-0.5}$ where R_0, the scattering unit, is about 80 m at the altitude of observation. The events were compared with Greisen's approximation of the Nishimura-Kamata distribution, which has been found to agree well with experimental observations. The number of particles in these cores could be estimated fairly accurately only up to 0.1 R_0 from the axis and ranged from 5×10^3 to 10^5 particles. The size estimates of the total number of particles in these events (based on the Nishimura-Kamata distribution) ranged from 3×10^4 to 10^5 particles. Nine showers were observed with two or more cores separated by as much as 2.5 meters. Four of these events gave evidence that the individual cores were not radially symmetric about their axis. The particle density seemed to fall off more steeply between the cores. Based on e-p cascade theory, the fact that 20% of the events were at least as peaked as $(r/R_0)^{-1}$ strongly indicates the frequent occurrence of nuclear interactions of the order of 10^{13} ev occurring at altitudes of 5 km or lower, and favors the concept of high elasticity with the primary particle surviving to low altitudes. (Dissertation Abstr.)

26279 THE MICHEL PARAMETER FOR THE BETA SPECTRUM FROM DECAYING COSMIC RAY MUONS. A. William Hogan. Thesis, Washington, D. C., Catholic Univ. of America, 1962. 65p.

The parameter ρ, a factor in the beta spectrum predicted for decaying muons, was determined using a large liquid scintillator employing approximately 250 gallons of a solution of α-NPO and p-terphenyl in decalin. The geometry of the detector permitted the use of its 52 independent cylindrical units in combinations convenient to the experiment. Cosmic-ray muons stopping in the detector initiated 9-μsec wide gates delayed by several microseconds during which the beta signal from decay was accepted by a multichannel pulse height analyzer. By use of coincidence circuits the beta signals were selected without biasing the energy spectrum. Background was determined simultaneously with spectrum measurements. The signal-to-background ratio was 700 to 1. Decreasing the size of the detector yielded information relative to possible energy losses. Half life measurements identified the events. Approximately three events per minute were detected, contributing to a spectrum of approximately 130 energy intervals. A total of 41,500 events was measured yielding a value for the Michel parameter of $\rho = 0.77 \pm 0.03$. The low energy region of the spectrum indicated a value of a second parameter η to be larger than its theoretical maximum of about 1. No numerical value was determined for η from this data due to uncertainties in the resolution function in this region. (Dissertation Abstr. 23: May 1963)

Criticality Studies

26280 (HW-77767) BRIEF SUMMARY OF CALCULATIONS ON CRITICAL MEASUREMENTS OF CYLINDERS IN CUBIC ARRAYS WITH OR WITHOUT REFLECTOR. F. R. Czerniejewski (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 29, 1963. Contract AT(45-1)-1350. 7p.

The theoretical methods of calculating a criticality constant near 1 for a series of equal cylinders set in a cubic array are given. In general, the interaction problem is treated with an eigenvalue matrix for the albedo. Special techniques are used for the three-dimensionality of the arrays and for the external reflectors. The vessels were made of 0.635 cm plastic, 20.32 cm OD. Each cylinder contained 5 liters of 92.6% U^{235} uranyl nitrate solution at an H/U^{235} of 58.8. Solution height was calculated to be 17.54 cm, although actual vessel height was 19.05 cm. Numerical results are given in tabular form. (M.C.G.)

26281 (PAN-105/IX) CRITICAL CALCULATIONS OF THE SLAB REACTORS. Krystyna Kowalska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 16p.

The problem of critical dimensions of an infinite slab multilayer multiplying system can be solved by the general procedure of K.M. Case. The angular neutron distribution and the critical core size can then be found by means of the solution of the Fredholm-type integral equation with an additional critical condition. Numerical calculations were done for the case of a multiplying slab surrounded by an infinite reflector assuming one energy group and isotropic scattering of neutrons. (auth)

26282 (RFP-315) EMPIRICAL ANALYSIS OF CRITICAL BARE ARRAYS OF CYLINDERS CONTAINING ENRICHED $UO_2(NO_3)_2$. C. L. Schuske, B. B. Ernst, and H. W. King (Dow Chemical Co. Rocky Flats Plant, Denver). May 29, 1963. Contract AT(29-1)-1106. 21p.

Empirical equations were found that relate the critical heights of cylinders in arrays with the array base dimensions for various surface-to-surface separations of the individual cylinders in the array. The methods were applied to critical arrays of cylindrical vessels containing aqueous solutions of $UO_2(NO_3)_2$. These critical data were generated by the critical mass facility of the Oak Ridge National Laboratory. (auth)

Elementary Particles and Radiations

Refer also to abstracts 24757 and 24758.

26283 (BNL-6957) Y^* PRODUCTION IN $\bar{p}$-P COLLISIONS. A. M. Thornkike (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 17p.

Pictures of $\bar{p}$-p interactions obtained in the 20-inch liquid hydrogen bubble chamber using $\bar{p}$ beams of 3.25

and 3.69 Bev/c were analyzed for evidence of anti-Y_1^* (1385) production and for comparison with anti-Λ^0 and anti-$N_{\frac{3}{2}}^*$ events. Fairly convincing evidence for $Y_1^*(1385)$ and for Y^*-$\bar{Y}^*$ pair production was obtained. Effective masses from the events, Y^* and $\bar{Y}^*$ production angles, and angular distributions of the antihyperon are among the data included. (D.C.W.)

26284 (NP-12881) THE UPPER LIMITS FOR COUPLING CONSTANTS IN QUANTUM FIELD THEORY. B. V. Geshkenbein and B. L. Ioffe (Akademiya Nauk S.S.S.R. Institut Teoreticheskoĭ i Eksperimental'noĭ Fiziki). 1963. 11p.

It is shown that the restrictions on the magnitudes of coupling constants at given masses in elementary particle interactions follow from general principles of quantum field theory without supplementary assumptions. The interaction of three boson fields with zero spin is considered and the coupling constant restrictions for these three fields are obtained. (C.E.S.)

26285 (NP-12882) OGRANICHENIYA NA VERSHINNUYU CHAST VZAIMODEISTVIYA TREKH CHASTITS. (Restrictions on the Vertex Part of Interaction of Three Particles). B. V. Gemkenbein and B. L. Ioffe (Akademiya Nauk S.S.S.R. Institut Teoreticheskoĭ i Eksperimental'noĭ Fiziki). 1963. 9p.

The maximum and minimum functions that limit the vertex function in the interactions of a three particle system were derived. The expressions were found to be dependent on the value of the renormalized mass function. A discussion of the vertex function in which the interacting particles were the deuteron, proton, and neutron was also presented. (C.E.S.)

26286 (PAN-376/VI) ON THE DETERMINATION OF THE PARTICLE MOMENTA IN THE NUCLEAR EMULSION EXPOSED IN A STRONG MAGNETIC FIELD. Marian Danysz, Krystyna Garbowska, Teresa Saniewska, and Ewa Skrzypczak (Warsaw. Univ. Inst. of Experimental Physics and Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1962. 22p.

An analysis is made of the error in the momentum determination for charged particles in nuclear emulsion exposed in a 180 kgauss magnetic field. The measurement technique is described, and the influence of various sources of errors is discussed. Formulas are given for the error of the momentum determination by means of the described techniques. The results of measurements on 24 Bev protons were analyzed. The momentum values and their spreads, obtained experimentally, were compared with the corresponding expected values. The experimental values are consistent with the expected values. (The mean error of the momentum determination based on 4 cm sections of 24 Bev/c proton tracks is ~11%). (auth)

26287 (PAN-395/VII) A SIMPLE REPRESENTATION FOR RELATIVISTIC MANY PARTICLE SYSTEMS. J. Werle (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Feb. 1963. 19p.

A complete orthonormal set of eigenstates of total energy, momentum $\vec{p} = 0$, angular momentum, its z component and parity is constructed for systems composed of any number of free particles of arbitrary mass and spin values. The procedure applied is a natural extension of the Jacob and Wick treatment of the two particle systems. It works equally well for relativistic and nonrelativistic cases. Only one unconventional quantum number that may be called collective helicity is introduced, The remaining quantum numbers are helicities and some kind of relative momenta of individual particles that can be directly measured. (auth)

26288 (PAN-401/VII)) GENERAL RELATIVISTIC THEORY OF MULTI-PARTICLE REACTIONS. J. Werle (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 21p.

The new relativistic angular momentum representation proposed for many particle states is here further developed and applied to the general S-matrix theory. Relativistic partial wave expansions are given in a comparatively simple form that may serve as a good basis for approximation methods and for an analysis of the experimental data. Various types of differential and total cross sections for reactions of the type $a + b \rightarrow 1 + 2 + \ldots + n$ are discussed. (auth)

26289 (PPAD-482D) TWO- AND THREE-BODY KINEMATICS PROGRAMS AND SUBROUTINES: TRAM 2 AND TRAM 3. J. L. Rosner (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Mar. 15, 1963. Contract AT(30-1)-2137. 25p.

Subroutines were written that perform two and three-body kinematics analyses. The incident particle's momentum in the laboratory frame and enough parameters to characterize the decay in the center-of-mass frame are entered. The target particle is stationary in the laboratory frame. Features to check energy- and momentum-conservation are included. Programs were written to test these subroutines and use them to compile kinematics tables. (auth)

26290 (PPAD-483D) THREE-BODY PHASE SPACE PROGRAM PHASP 3. J. L. Rosner (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Mar. 15, 1963. Contract AT(30-1)-2137. 17p.

A program was written that calculates three-body phase space distributions. Densities of points in phase space may be plotted vs. either two-particle effective mass in the center-of-mass system, or laboratory momentum of the third particle. (auth)

26291 (UCRL-7087) THE IONIZATION OF ALKALI ATOMS BY ELECTRON BOMBARDMENT. F. S. Baker and G. O. Brink (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 17, 1962. Contract W-7405-eng-48. 54p.

A new experimental method was developed by which relative measurements of ionization cross sections can be normalized to absolute values. The method consists essentially of combining crossed-beams techniques, adsorption of gases on solid surfaces, and radioisotope tracer detection. An atomic beam containing the radioactive tracer is crossed rectilinearly with an electron beam. The reaction products are adsorbed on collector surfaces and detected in a scintillation counter. The atomic beam is also quantitatively sampled by adsorption. Under consideration of experimental parameters, the value of the total ionization cross section is then directly proportional to the ratio of the counting rates R_{ion}/R_{beam}. The relative ionization cross-section curves of K, Rb, and Cs were normalized and are presented. The values of a for the relation $Q_i = aE^{-6}$ expressing the simple ionization cross sections as a function of electron energy are also given. The total scattering cross sections of K, Rb, and Cs were partially resolved into their components. Finally, the autoionization structure of Cs is related to the known energy levels of the atom. (auth)

26292 (UCRL-10718) EFFECTS OF THE SINGLE PION EXCHANGE IN THE REACTION $p + p \rightarrow n + p + \pi^+$

(thesis). Joseph T. Lach (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 11, 1963. Contract W-7405-eng-48. 107p.

The distribution of neutrons in energy and angle from the reaction $p + p \rightarrow n + p + \pi^+$ at an incident proton momentum of 2.5 Bev/c is studied. The coordinates of the three final-state particles are measured by an array of plastic scintillation counters, the energy of the recoil neutron being determined through its flight time. The range of measured neutron angles is limited to 4 to 60 deg, and the range of recoil momentum is from approximately 150 to 330 Mev/c. Data are recorded on magnetic tape in a format directly acceptable to an IBM 7090 computer where sorting and kinematical fitting is done. A Monte Carlo computation is made in which the effects of the complex resolution functions of the apparatus and the fitting code are investigated and used to compute the overall efficiency and resolution of the apparatus. Because of geometrical limitations of the angular region in which the final state pion and proton could be detected, and the inability to distinguish between them in 18% of the events, the analysis is limited to a region of θ^*, the pion-proton scattering angle, bounded by $-0.5 < \cos(\theta^*) < +0.5$. Comparisons are made with predictions of the one-pion exchange model. A Chew-Low extrapolation is performed and deviations from a linear extrapolation are found. The peripheral model predictions of Selleri agree well with the observed position and reasonably well with the observed shape of the 3/2, 3/2 resonance if an integration is made over momentum transfer. The cross section, as a function of momentum transfer, deviates from the predicted behavior. (auth)

26293 WORKING CONFERENCE ON WEAK INTERACTIONS. V. Belyaev. At. Energ. (USSR), 14: 423(Apr. 1963). (In Russian)

In December 1962 a conference on weak interactions was held at the Laboratory for Theoretical Physics of the Joint Institute for Nuclear Investigations. One of the problems discussed was the effect of the form factor in weak interactions, in particular in hyperon and K-meson decays and in the $\nu + N \rightarrow N + 1 \ldots$ type reactions. During the discussions it was brought out that the Brookhaven μ-meson experiments on the neutrino may be also explained by assuming the existence of a single neutrino in nature; the large number of μ-mesons observed in the experiments is attributed to the contribution of a pseudocascade form factor. Experiments were proposed for confirming this theory. The cosmological role of the neutrino was reviewed in several papers; a new theory of the evolution of the universe, opposed to the assumptions of Gamow and Alpher, was presented; in it the formation of light elements is forbidden. The two-component and four-component theories of the two, electron and muon, neutrinos are considered to be equivalent and cannot be differentiated in experiments not making use of the gravitational field. The role of the energy-dependent matrix elements in the radiative capture of μ-mesons by the nuclei was clarified. (TTT)

26294 APPLICATION OF THE THEORY OF FUSION TO THE NEW EXPANDED MODEL OF ELEMENTARY PARTICLES. Jean-Pierre Vigier and Louis de Broglie. Compt. Rend., 256: 3390-4(Apr. 17, 1963). (In French)

The idea that fusion results from strong interactions associated with new internal gauge invariances was developed from the relativistic rotator model. All the nonlepton particles result, following a suggestion of Yukawa, from the combination of four fundamental particles. (tr-auth)

26295 PRODUCTION OF DENSE ELECTRON BEAMS IN RELATIVISTIC REGIME. Gérard Zepp. Compt. Rend., 256: 3426-29(Apr. 17, 1963). (In French)

A study was made to determine the electrode shapes which permit a dense electron beam with a cylindrical shape to be obtained. The case of thin beams with high current density and high anode voltage was studied in detail. (tr-auth)

26296 TABLE OF ELEMENTARY PARTICLES ASSOCIATED WITH THE NEW EXPANDED MODEL OF ELEMENTARY PARTICLES. Jean-Pierre Vigier and Louis de Broglie. Compt. Rend., 256: 3551-5(Apr. 22, 1963). (In French)

Starting from the Yukawa hypothesis, one can construct a Mendeleev-like table of external-internal states resulting from the fusion of 2, 3, and 4 basic units with external-internal spin $\frac{1}{2}$. The extension of the procedure to a higher number of units presents no difficulties of principle. (tr-auth)

26297 ELECTRON-PROTON AND MUON-PROTON INELASTIC SCATTERING AT THE 3/2 RESONANCE IN THE ISOBARIC MODEL. Jean-Marie Abillon. Compt. Rend., 256: 3605-8(Apr. 22, 1963). (In French)

A coupling constant and an experimental form factor of the isobar $(^3/_2, ^3/_2)$ were determined using a simplified isobar model. The cross sections for the production of μ mesons by electrons or muons were also determined. (tr-auth)

26298 EFFECT OF THE HYPERFINE STRUCTURE OF THE MESIC ATOM ON THE CAPTURE OF μ MESONS BY LITHIUM-6. Jean Delorme (Institut de Physique Nucleaire, Lyon). Compt. Rend., 256: 3658-60(Apr. 22, 1963). (In French)

By use of an effective capture Hamiltonian of the (V-A) type with "renormalization" and "velocity" terms, the probabilities for the capture of the μ^- meson in the two hyperfine states of the mesic atom Li^6-μ could be calculated when the final state is the ground level of He^6. It was shown that the measurement of the rate of capture can yield important information on the form of interaction, particularly on the existence of the pseudoscalar term. (tr-auth)

26299 MEASUREMENT OF THE CROSS SECTION FOR THE CREATION OF PAIRS OF ELECTRONS BY ELECTRONS AND MUONS AT KNOWN ENERGIES. M. Gailloud and C. Piron (Université de Lausanne, Switzerland). Helv. Phys. Acta, 36: 164-9(1963). (In French)

The cross section for direct pair production by electrons and muons of well-determined energy was measured in nuclear emulsions. The following results were obtained: electrons of 340 ± 20 Mev, 66 ± 8 mb per emulsion nucleus; electrons of 640 ± 20 Mev, 108 ± 13 mb per emulsion nucleus; electrons of 670 ± 20 Mev, 107 ± 13 mb per emulsion nucleus; electrons of 730 ± 20 Mev, 110 ± 20 mb per emulsion nucleus; and mesons (μ^-) of 8.2 ± 0.07 Bev, 8.4 ± 2.2 mb per emulsion nucleus. The correction for pseudotridents needed only in the electron case was applied. This correction was checked experimentally in these emulsions by measuring the distribution of pairs as a function of distance from the primary track. The cross sections were compared with the theoretical calculations of Block, King, and Wada and found to be somewhat larger. (auth)

26300 CLASSICAL STATISTICAL MECHANICS OF A SYSTEM OF PARTICLES. D. Ruelle (Eidgenössische Technische Hochschule, Zurich). Helv. Phys. Acta, 36: 183-97(1963). (In English)

The free energy of a system of particles interacting by a two-body potential was investigated for the canonical ensemble. The existence of a limit for the free energy per particle when the system becomes infinite and the stability conditions were proved rigorously for a large class of potentials. It was also shown that the pressure is a continuous function of the volume for bounded potentials. The grand canonical ensemble was investigated in a similar manner and a generalization of the results of Yang and Lee is given. (auth)

26301 A COMPLEMENTARY MODE OF BEAM-WAVE INTERACTION IN CROSSED FIELDS. O. P. Gandhi (Univ. of Michigan, Ann Arbor). J. Electron. Control (1), 14: 393-401(Apr. 1963). (In English)

In a positive-sole crossed-field interaction region where the sole electrode is at a higher d-c potential than the slow-wave structure, there exists a complementary mode of interaction such that the total wave amplitude as a function of distance in a forward-wave positive-sole interaction region is of the same general form as that obtained by normal (negative sole) backward-wave crossed-field interaction and vice versa. A small-signal analysis is developed for this mode of interaction and the excitation of beating displacement and charge density waves on the electron stream in the case of forward-wave interaction is shown. These waves beat at the first maximum ($2\pi DN$ between 0.5 and 2.0) to produce an optimum r-f modulation of the stream at that point. An efficient backward-wave amplifier of the complementary mode type is proposed. (auth)

26302 A SINGLE-VELOCITY ANALYSIS OF A MULTI-VELOCITY ELECTRON STREAM. J. E. Carroll (Services Electronics Research Lab., Harlow, Essex, Eng.). J. Electron. Control (1), 14: 403-24(Apr. 1963). (In English)

A new approximate method of analyzing multi-velocity electron streams is presented in detail. No new effects are presented but the method gives good agreement with previous analyses for a wide range of thermal velocity problems. These include the spreading of a cylindrical electron beam, loss of signal on cyclotron waves of finite phase velocity, and modifications to the space-charge parameter of travelling-wave tubes. The advantages of the method are firstly that it can be applied to three-dimensional as well as one-dimensional problems without the complications of density function techniques; and secondly that it retains many of the features of a single-velocity theory. (auth)

26303 CYCLOTRON RADIATION OF ELECTRONS HAVING A TWO-DIMENSIONAL MAXWELLIAN DISTRIBUTION. B. A. Trubnikov and V. B. Yakubov (Moscow Inst. of Atomic Energy). J. Nucl. Energy, Pt. C, 5: 7-14 (Jan.-Feb. 1963). (In English)

The cyclotron radiation of electrons having a two-dimensional Maxwellian distribution and that are in a magnetic field is considered. Formulas are derived for the intensity of the radiation and coefficient of absorption. These are found to be in good agreement with the numerical calculations of Beard and Baker. (auth)

26304 STUDY OF THE WHITE STARS PRODUCED BY THE INTERACTIONS OF 27-Bev PROTONS IN A NUCLEAR EMULSION. Jeanne-Marie Habaru (Université, Liège). Mem. Soc. Roy. Sci. Liege, 8: 1-88(1963). (In French)

The interactions of the proton beam from the CERN synchrotron with the nuclei of the emulsion of the Ilford G5 plate at an energy of 27 Bev were studied. The theoretical and experimental results in the realm of high-energy nuclear reactions acquired previously are reviewed. The results of a preliminary study on the definition of the mean free path of protons in the emulsion and of the inelastic cross section of nucleon-nucleon interactions are reported. Nucleon-nucleon events involving only angle measurements are studied. The techniques used for the measurements of multiple scattering and ionization are reported. Then the results obtained from an angular and energy study of the secondary particles of proton-nucleon interactions are given. (tr-auth)

26305 IMPLICATIONS OF A NEW APPROACH TO QUANTUM ELECTRODYNAMICS IN ELECTRON-PROTON SCATTERING. Mendel Sachs (McGill Univ., Montreal and Boston Univ.) and Solomon L. Schwebel. Nucl. Phys., 43: 204-12(May 1963). (In English)

The implications of a new approach to quantum electrodynamics in high energy electron-proton scattering are investigated. The assumption is made that the proton is a classical point particle with finite mass. The calculation is carried out in the approximation in which the non-linear equations of formalism can be linearized and use is made of the first Born approximation to determine the cross section. The differential cross section is found to depend sensitively on the fundamental length that is inherent in the theory. Its magnitude $g_M = 0.2087 \pm 0.0001$ fm was already determined by the measured values of the Lamb shift in hydrogen. There are no free parameters in the calculation. It is found that, compared with the standard Mott result for relativistic point particle scattering, better agreement is obtained with the data, except in the regions of very high momentum transfer. (auth)

26306 BREAKUP OF DEUTERONS BY 14.4 Mev NEUTRONS. K. Ilakovac, L. G. Kuo, M. Petravić, I. Šlaus, and P. Tomaš (Inst. "Rudjer Bošković", Zagreb). Nucl. Phys., 43: 254-63(May 1963). (In English)

Measurements of proton spectra from the D(n,p)2n reaction at 14.4 Mev were extended to larger angles. The high energy peak corresponding to the two neutron final state interaction gradually disappears. Breakup protons are peaked forward. Theoretical analysis was extended to take into account the n-p in addition to the n-n final state interaction. (auth)

26307 PHASE SHIFTS FOR NUCLEON-NUCLEON SCATTERING. [PART] II. T. Gajewski (Univ. of Lodz, Poland). Nucl. Phys., 43: 316-20(May 1963). (In English)

A simplification of the formulas for the phase shifts for nucleon-nucleon scattering with spin-orbit interaction is presented. The properties of these simplified formulas are discussed and some other formulas are obtained giving phase shifts for singular potentials appearing in nucleon-nucleon tensor interaction. (auth)

26308 ON THE ISOVECTOR FORM FACTORS OF THE NUCLEON. A. P. Balachandran and H. Pietschmann (Universität, Vienna). Nucl. Phys., 43: 321-9(May 1963). (In English)

The discussion of the equal time commutation relation for the isospin density and the consequences it implies for the isovector form factors of the nucleon are presented. It is shown that in the one-nucleon approximation a set of equations may be derived from this commutation relation that are adequate to determine the functions $F_1^V(s)$ and $F_2^V(s)$ assuming the isovector magnetic moment to be a given parameter. A comparison of the results obtained with the experimental data is also carried out. (auth)

26309 SPIN-DEPENDENT ANALOGUES OF THE OPTICAL THEOREM. R. J. N. Phillips (Atomic Energy

Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 43: 413-16(May 1963). (In English)

If there are spin-dependent terms in a forward scattering amplitude, their imaginary parts are related to total cross sections with suitable incident polarizations. (auth)

26310 PION-LAMBDA SCATTERING. Gernot Eder (Universität, Vienna). Nucl. Phys., 43: 490-1(May 1963). (In English)

The connection between the asymmetry parameters of the Ξ-decay and the π-Λ scattering is discussed. (auth)

26311 ENERGY ABSORPTION, PENETRATION, AND DIFFUSION OF γ BEAMS IN AN INFINITE HOMOGENEOUS MEDIUM. C. M. H. Hashmi (Technische Hochschule, Munich). Nukleonik, 5: 67-74(Feb. 1963). (In German)

Gamma-dose-output measurements were carried out in a large water volume at γ source distances up to about eight mean free path lengths. The point γ sources were prepared from Na^{24}, K^{42}, Sc^{46}, Mn^{56}, Co^{60}, Cu^{64}, Au^{198}, and Hg^{203} by (n,γ) reactions in the FRM Reactor. They emit γ beams with energies between 0.28 and 2.8 Mev. A homogeneous hollow ionization chamber of graphite, filled with 50 cm^3 air at standard temperature and pressure, was used for the ionization measurements. The ionization current was measured with a vibrating condenser electrode. The decay rate of the γ source was determined by β-π coincidence and the 4-π geometry counter method. The dose structure factors were determined in dependence on the energy and distance from the γ source. They were compared with theory. The results, in general, agree well with the Goldstein calculations. The absolute calibration of the dose output (rad/sec × c) can be used for the determination of the decay rates of isotopes with known γ energies in the range from 10^{-3} to 10^{3} c with an accuracy of 3%. (tr-auth)

26312 MASS RELATIONS AND SIMPLE LIE GROUPS OF RANK 2. B. Diu (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cimento (10), 28: 466-78(May 1, 1963). (In English)

Mass relations in connection with the classification of elementary particles in supermultiplets are obtained in simple Lie groups C_2 and G_2 of rank 2. The tensorial form of the irreducible representations of the rank 2 groups is derived. Although only mass relations are investigated, the matrix elements derived are applicable in the calculations of other properties of elementary particles. (C.E.S.)

26313 INTERACTING MIXED SYSTEM OF BOSONS AND FERMIONS. I. SINGLE PARTICLE AND SOME COLLECTIVE EXCITATIONS IN A DILUTE MIXTURE OF ^{4}He AND ^{3}He AT VERY LOW TEMPERATURES. J. Sawicki (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 28: 479-99(May 1, 1963). (In English)

The single boson and the single fermion energy spectra are studied for a mixed interacting system of bosons and fermions in the zero temperature limit. A combined method of the Bogoliubov approximation for the bosons and the Random Phase Approximation (RPA) for the fermions is employed. For the dressed bosons excitations correspond to a strong coupling of single bosons to the collective motion of fermion particle-hole pairs. This coupling is, in important physical cases, capable of introducing a damping of the single boson states in the region of small momenta, i.e., of the phonons. The energy of such modes is a sensitive function of the effective boson-fermion interaction and of the density. The single fermion spectra of fermions dressed in boson-fermion pairs are similar in shape to those of the Hartree-Fock approximation; only the energy function $E = E(p)$ is, respectively, shifted as a whole, and is slightly flattened out. A schematic pseudopotential and effective mass model is used as a numerical illustration for the case of the dilute liquid He^4–He^3 mixture. (auth)

26314 JOST FUNCTIONS AND DETERMINANTAL METHOD IN POTENTIAL SCATTERING. P. Kaus and C. J. Pearson (Univ. of Southern California, Los Angeles). Nuovo Cimento (10), 28: 500-27(May 1, 1963). (In English)

Some properties of Jost functions are reviewed for real and complex angular momenta and compared to the determinantal expansion. The exact phase shifts and Jost functions in the complex k-plane are calculated for S and P-waves and compared to the first and second-order determinantal expansion. (auth)

26315 POSSIBLE QUANTUM NUMBERS OF $K\bar{K}$ RESONANCE. S. N. Biswas (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 28: 528-32 (May 1, 1963). (In English)

It is argued that the exchange of Sakurai's β_T quanta could explain the occurrence of the observed ρ and K^* resonances. The characteristics of these resonances have been calculated using the N/D method of dispersion theory. (auth)

26316 DEUTERON ELECTROMAGNETIC FORM FACTORS. M. Gourdin (Laboratoire de Physique Théorique, Orsay, France). Nuovo Cimento (10), 28: 533-46 (May 1, 1963). (In English)

An expression of the deuteron electromagnetic form factors is given in the impulse approximation using a nonrelativistic wave function for the deuteron. The meson exchange current contributions and the off-mass shell-dependence of the nucleon electromagnetic current are neglected. (C.E.S.)

26317 ON THE GREEN'S FUNCTION OF POTENTIAL SCATTERING. M. Verde (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 28: 547-66(May 1, 1963). (In English)

The Green's function in some potential scattering problems of spherical symmetry is written as an integral of the product of the Green's functions G_a corresponding to the angular variables and G_r corresponding to the radial variables. The integration is carried along a suitable line C in the plane of complex angular momentum. If C surrounds the spectrum of G_a the usual partial waves expansion is obtained, if C surrounds the spectrum of G_r a different expansion results that is the most suitable for describing collisions involving small wave lengths. In particular it is shown how the Green's function that characterizes a wave propagation phenomenon approaches the classical limit, leading to the ray propagation of ordinary mechanics. (auth)

26318 ON THE SINGULARITIES OF THE SCATTERING AMPLITUDE IN A SIMPLE FIELD THEORETIC MODEL. R. M. Rockmore (Brandeis Univ., Waltham, Mass.). Nuovo Cimento (10), 28: 590-6(May 1, 1963). (In English)

Charged scalar fixed-point-source theory is considered in the regime of strong coupling from the standpoint of the Chew-Low equation as a model field theory within which one cannot distinguish which of two particles is elementary and which is a bound state of the other and a pion. In the case of the one-meson approximation, it is shown that this reciprocal relationship extends even to those values of the renormalized coupling constant for which the isobar pole

becomes unphysical. The same extension of reciprocity to the second Riemann sheet also obtains in the one-meson approximation in a bound-state model recently considered by Low. (auth)

26319 ($\pi\pi$) AND ($K\pi$) RESONANCES. S. N. Biswas and V. Gupta (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 28: 597-9(May 1, 1963). (In English)

A theoretical analysis of the various possible decay modes of the $K\bar{K}$ resonance based on the selection rules respected by strong and electromagnetic interactions was made for the purpose of determining its possible spin and parity assignments. (auth)

26320 THEORY OF FERMION REGGE POLES. D. Amati, A. Stanghellini, and K. Wilson (CERN, Geneva). Nuovo Cimento (10), 28: 639-50(May 1, 1963). (In English)

A theory for spinor Regge poles is developed on the basis of the multiperipheral model. A set of linear integral equations for the corresponding high-energy amplitudes is obtained, which shows the characteristic $s^{\alpha(t)}$-behavior. The eigenvalue problem presents new features that are directly connected with the existence of spin. There are two dominant trajectories, one being the complex conjugate of the other. In the weak coupling limit, explicit expressions for the trajectories are given: they are real in the bound state region and coincide for $t = 0$. The relation between the results and the properties of bound states is discussed. The complex conjugate character of the trajectories in the diffractive region is found to be related to the existence of two opposite parity bound states for any particular total angular momentum. (auth)

26321 ON THE Y_1^*-RESONANCE. K. Nishimura (Università, Rome). Nuovo Cimento (10), 28: 664-6(May 1, 1963). (In English)

The Λ-π elastic scattering amplitude is investigated from the point of view of the bootstrap mechanism of the Y_1^* exchange. The Σ and ABC resonance low-mass intermediate states that are compatible with the conservation laws are also considered. Their contribution to the Y_1^* self-generation is investigated. (C.E.S.)

26322 A NEW CLASSIFICATION OF ELEMENTARY PARTICLES AND RESONANCES. F. Halbwachs (Institut Henri Poincaré, Paris). Nuovo Cimento (10), 28: 695-705 (May 16, 1963). (In English)

The recent discovery of a second neutrino and of a K^-p charge exchange with strangeness +1 suggests a generalization of Sakata's scheme for elementary particles and resonances, with four basic particle states. This is provided by the De Broglie, Vigier, Yukawa scheme based on the theory of the relativistic rotator. (auth)

26323 INTERACTIONS OF 16 Gev/c π^--MESONS IN HYDROGEN LEADING TO THE PRODUCTION OF STRANGE PARTICLES. J. Bartke (Inst. of Nuclear Research, Polish Academy of Sciences, Krakow). Nuovo Cimento (10), 28: 712-23(May 16, 1963). (In English)

Meson(π) production in 157 jets with strange-particle production resulting from collisions of 16 Bev/c mesons(π^-) in hydrogen bubble chamber was studied. The events represent two reactions: associated production and K-pair production. In both groups the production of mesons(π) shows a number of features similar to those found in ordinary jets. It is shown that from energy and momentum balance one can get some conclusions concerning the emission of mesons (K) in associated production and the emission of nucleons in K-pair producing reactions. (auth)

26324 INNER COULOMB CORRECTIONS TO PION-NUCLEON SCATTERING PHASE-SHIFTS. H. J. Schnitzer (Brandeis Univ., Waltham, Mass.). Nuovo Cimento (10), 28: 752-60(May 16, 1963). (In English)

A calculation of the inner Coulomb corrections to pion-nucleon phase shifts is presented that does not depend on an expansion in powers of kr_0. The estimates obtained depend on the choice of simple, reasonable potential models. It is noted that the same corrections may be useful in analyzing other elementary particle reactions. (auth)

26325 ASYMPTOTIC BEHAVIOR OF THE S-MATRIX IN POTENTIAL SCATTERING FOR LARGE IMAGINARY VALUES OF ANGULAR MOMENTUM. F. Calogero (Princeton Univ., N. J.). Nuovo Cimento (10), 28: 761-72 (May 16, 1963). (In English)

It is proved that the analytically continued partial-wave scattering amplitude produced by Yukawian potentials vanishes as $|\mathrm{Im}\ l| \to \infty$. (auth)

26326 CONSEQUENCES OF NO DOUBLE-CHARGE EXCHANGE AT HIGH ENERGIES. V. Gupta (Tata Inst. of Fundamental Research, Bombay) and K. V. L. Sarma. Nuovo Cimento (10), 28: 794-7(May 16, 1963). (In English)

It is suggested that the cross section for double charge-exchange should go to zero with increasing energy at a faster rate than the usual charge-exchange cross-section. The consequences and possible experimental support for this suggestion are given. Finally, it is conjectured that with increasing energy lower and lower quantum number transfer takes place between the two incoming particles. (auth)

26327 A PHENOMENOLOGICAL DISCUSSION OF INELASTIC COLLISIONS AT HIGH ENERGIES. L. Van Hove (CERN, Geneva). Nuovo Cimento (10), 28: 798-817(May 16, 1963). (In English)

A phenomenological discussion is given of inelastic collisions of strongly interacting particles at very high energies. The method followed is to try out simple forms for the wave function of the inelastic final state and to determine under which conditions they are compatible through unitarity with the known or conjectured properties of diffraction scattering. With the exception of the slow shrinking of the peak, the properties of diffraction are found compatible with very simple inelastic final states having no correlation between secondaries. Compatibility requires, however, the longitudinal momentum distribution to tail off slowly toward large values of the longitudinal momentum, thereby imposing a slow increase of the average multiplicity with incident energy. This behavior is in qualitative agreement with observation. The shrinking of the diffraction peak is found to require a certain amount of correlation between secondaries in inelastic collisions, and our discussion suggests which general type of correlation may be the inelastic counter-part of the shrinking phenomenon. (auth)

26328 A DOUBLE DISPERSION RELATION FOR A CLASS OF NONLOCAL POTENTIALS. J. T. Cushing (Univ. of Iowa, Iowa City). Nuovo Cimento (10), 28: 818-33(May 16, 1963). (In English)

The analytic properties of the potential scattering amplitude, considered as a function of the two complex variables energy and momentum transfer, are investigated for a nonlocal interaction assumed to be a superposition of a purely local Yukawa potential of the type extensively treated in the current literature and of a purely nonlocal, central, separable one. The exact partial-wave scattering amplitudes are constructed and the analytic properties of the total scattering amplitude are studied through the partial-

wave expansion and the Sommerfeld-Watson transformation. If suitable restrictions are placed on the asymptotic form of the angular-momentum-dependence of the separable potential to allow a Sommerfeld-Watson transformation to be made, then the total scattering amplitude can be written as a double dispersion relation in the energy and momentum transfer, with possibly a finite number of pole terms and subtractions. The scattering amplitude for the class of nonlocal potentials considered has a cut along the negative real energy axis that would not be expected from the analogous results for a purely local potential. (auth)

26329 ELEMENTARY AND COMPOSITE PARTICLES IN THE LEE MODEL. B. Diu (Laboratoire de Physique Théorique et des Hautes Energies, Orsay, France). Nuovo Cimento (10), 28: 834-42(May 16, 1963). (In English)

Investigation of the Lee model shows that, while in some cases an experimental test can decide whether a given particle is elementary or composite, in other cases different hamiltonians, involving different sets of elementary particles, can describe the same situation. In these last cases, the elementary or composite character of a particle depends on the choice of the hamiltonian, and all particles are fundamentally equivalent. (auth)

26330 ON THE SPINS OF MESON-MESON RESONANCES. G. F. Wolters (Zeeman Laboratorium, Amsterdam). Nuovo Cimento (10), 28: 843-9(May 16, 1963). (In English)

The disintegration of two-meson resonances, produced in two-body reactions, is studied. It is shown that the resonance-spin can be obtained from measurement of the polar angle for the disintegration in the resonance rest-system, for a sufficiently large number of events selected in an appropriate way. (auth)

26331 A NOTE ON THE FERMION REGGE POLES AND HIGH-ENERGY BACKWARD SCATTERING. A. Deloff and J. Wrzecionko (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Nuovo Cimento (10), 28: 868-71(May 16, 1963). (In English)

The fermion Regge pole hypothesis was applied to pion-nucleon backward scattering at high energies. Contrary to the previous work of others it was shown that the backward cross section contains an oscillatory term that does not vanish at high energies. The polarization produced in this reaction was also derived and differed from previous work. It was suggested that an unjustified continuation of the cross section from the physical region of the u channel to the physical region of the S channel was used in previous derivations. (C.E.S.)

26332 THE PRODUCTION AND USE OF HIGH RESOLUTION GAMMA RAYS. P. Axel (Univ. of Illinois, Urbana). Phys. Letters, 4: 320-3(May 15, 1963). (In English)

The extremely high resolution required to identify individual levels at high excitation can be obtained indirectly from slow neutrons by using them to produce variable energy gamma rays. The energy variability, resolution, and intensity of these gamma rays are discussed. Estimates of their interactions with nuclear levels are given. These estimates are supported by interpreting recent data on the scattering of thermal-neutron capture gamma rays. (C.E.S.)

26333 PION-PION AMPLITUDES FROM THE BOUNDARY CONDITION MODEL. W. W. S. Au and E. L. Lomon (Massachusetts Inst. of Tech., Cambridge). Phys. Letters, 4: 327-30(May 15, 1963). (TID-18547). (In English)

The boundary condition model is used for the theoretical treatment of relativistic strong interactions of mesons(π) containing the dominant dynamical aspects of the Mandelstam relations as well as the correct analytic properties of the S matrix and exact unitarity. The models for the L = 0 (T = 0,2) and L = 2(T = 1) channels are presented, satisfying crossing symmetry to the extent possible when ignoring higher partial waves. Values of the scattering lengths and symmetry point amplitudes are given for a few sets of model parameters. (C.E.S.)

26334 MASS AND DECAY PARAMETERS OF Ξ – PARTICLES. H. Schneider (CERN, Geneva). Phys. Letters, 4: 360-1(May 15, 1963). (In English)

The mass, lifetime, and decay-asymmetry parameters of hyperons(Ξ^-) and the mass of the hyperon(Ξ^0) are reported. The results are obtained from the exposure of a hydrogen bubble chamber to a beam of mesons(K^-) at 1.455 ± 0.025 Bev/c. (C.E.S.)

26335 POSITRON ANNIHILATION IN CONDENSED GASES. D. C. Liu and W. K. Roberts (National Aeronautics and Space Administration, Cleveland). Phys. Rev., 130: 2322-5(June 15, 1963).

The time distributions of positron annihilation in condensed H_2, He, N_2, and O_2 were measured. The free positron annihilation lifetime, τ_1, for each substance shows a gross density dependence within a single phase and across the liquid-solid phase transition. For these materials studied τ_1 is shorter than that predicted by the spin-averaged cross section for the 1S state annihilation pair and varies directly with the ratio of the first electron ionization potential to the outer shell electron density. Positronium is formed in all these substances. The orthopositronium pickoff lifetime, τ_2, appears to be sensitive to the liquid-solid phases change in H_2 and N_2 but insensitive to the normal-superfluid state transition in He. (auth)

26336 POSITIVE PION PRODUCTION BY POLARIZED X RAYS BETWEEN 227 AND 373 Mev. R. C. Smith and R. F. Mozley (Stanford Univ., Calif.). Phys. Rev., 130: 2429-40(June 15, 1963).

Measurements were made of the ratio of the π^+ photoproduction cross sections at right angles to and along the electric field vector. Data were taken at 45, 90, and 135° at energies of 227, 240, 342, and 373 Mev. A comparison of the data with the predictions of a phenomenological analysis using only S and P waves shows less than 0.1% chance of obtaining such results without the inclusion of higher angular momenta, and hence, demonstrates even more convincingly the need for a meson current term that was indicated by other measurements. A comparison is made with the relativistic dispersion relations of McKinley that include an approximation for the γ,ρ,π coupling. At the resonance energy the polarization asymmetry is insensitive to this coupling and is in good agreement with the McKinley prediction. At lower energy the agreement is not as good but the data seem to substantiate the need for a negative γ,ρ,π coupling constant. (auth)

26337 RADIATIVE ρ-MESON DECAY. Paul Singer (Northwestern Univ., Evanston, Ill.). Phys. Rev., 130: 2441-8(June 15, 1963).

The radiative decays of the charged and neutral ρ meson are discussed assuming that the decay vertices are dominated by the low-mass $\pi\pi$ and $\omega\pi$ intermediate states. The transitions $\rho \rightarrow \pi + \gamma$, $\rho^0 \rightarrow \pi^+ + \pi^- + \gamma$, $\rho^0 \rightarrow \pi^0 + \pi^0 + \gamma$, $\rho^{+,-} \rightarrow \pi^{+,-} + \pi^0 + \gamma$ and $\rho^0 \rightarrow \eta + \gamma$ are considered in detail. The probability for the emission of a photon with energy exceeding 15 Mev in the process $\rho^0 \rightarrow \pi^+ + \pi^- + \gamma$ relative

to the 2π decay is found to be 1.7×10^{-2}, indicating that the $(2\pi + \gamma)$ decay width is comparable or greater than the $(\pi + \gamma)$ one. The internal bremsstrahlung and direct emission processes are included in the calculation of the various partial widths. (auth)

26338 ENERGY DEPENDENCE OF PROTON ELECTROMAGNETIC FORM FACTORS. S. H. Patil (Univ. of California, San Diego). Phys. Rev., 130: 2448-9(June 15, 1963).

A χ^2 analysis of electron-proton scattering is made to test for the energy dependence of the form factors, in the Regge pole form, using the slope of the pole as a parameter. It is found that the form factors can tolerate considerable energy dependence. However, decisive conclusion regarding such an energy dependence has to await the data at higher energies. (auth)

26339 REACTION $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ FROM 360 TO 800 Mev. Janos Kirz, Joseph Schwartz, and Robert D. Tripp (Univ. of California, Berkeley). Phys. Rev., 130: 2481-4(June 15, 1963). (UCRL-10676)

The reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ is studied in the Lawrence Radiation Laboratory's 72-in. hydrogen bubble chamber. Events are located by scanning the pictures for π^+ tracks. Cross sections, Dalitz plots, and $\pi^+\pi^-$ and π^+n mass spectra are given at 360, 430, 460, 480, 555, 605, 673, and 780-Mev beam energies. No clear evidence is found for $\pi^+\pi^-$ resonances between threshold and 680 Mev. However, there is a strong preference for high $\pi^+\pi^-$ effective masses, especially at the lowest beam energies. Arguments are given to ascribe this anomaly to the I = 0 state of the $\pi-\pi$ system. The $N^*_{\frac{3}{2}}(1238)$ isobar is observed in its negative charge state. The angular distribution of its production is discussed. (auth)

26340 EXTRAPOLATION METHODS AND THE NUCLEON-DEUTERON BREAKUP REACTION. I. J. R. Aitchison (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 130: 2484-94(June 15, 1963). (BNL-6754)

The Chew-Low extrapolation as applied to the nucleon-deuteron breakup reaction is studied. Singularities of the amplitude and cross sections are located using perturbation theory and simple final-state interaction theory. The measured cross sections, whose kinematic singularities are exhibited, are expressed in terms of the invariant Chew-Low cross sections. The experimental procedure is outlined, and forms are suggested for the fitting curves. (auth)

26341 FINAL-STATE INTERACTIONS IN THE ELECTRODISINTEGRATION OF DEUTERIUM. J. Nuttall and M. L. Whippman (Cambridge Univ., Eng.). Phys. Rev., 130: 2495-2501(June 15, 1963).

The cross section for the inelastic electron-deuteron scattering process is calculated using a semirelativistic approximation. The final-state interaction between the outgoing nucleons is estimated using approximate wave functions derived from the Gammel-Thaler potential. The rescattering correction is found to lead to a decrease in the peak value of the cross section, varying from about -5% at an electron momentum transfer of $1.4F^{-1}$ to about -2% at a momentum transfer of $4F^{-1}$. Various relativistic corrections are considered, and an ambiguity in the normalization of the semirelativistic wave functions is discussed. Finally, the neutron form factors are redetermined. (auth)

26342 $e^+ + e^- \rightarrow \pi^+ + \pi^- + \pi^0$ AND OVERLAPPING RESONANCES. David R. Harrington (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 130: 2502-5(June 15, 1963).

The process $e^+ + e^- \rightarrow \pi^+ + \pi^- + \pi^0$ is suggested as a useful tool for studying overlapping resonances. A simple model is used to estimate the effects of the two-pion interactions upon the form of the invariant amplitude. Except for a common factor, that depends only upon the total energy, the two-pion effects occur additively in the resulting form in contrast to the multiplicative effects suggested by others. (auth)

26343 SINGULARITY OF THE REGGE AMPLITUDE. J. N. Islam, P. V. Landshoff, and J. C. Taylor (Cambridge Univ., Eng.). Phys. Rev., 130: 2560-5(June 15, 1963).

It is shown that the Regge amplitude a(l,s) has singularities at certain fixed, real, physical values of s for all nonphysical values of l. These singularities are not normal thresholds and are not singularities of the complete amplitude A(s,t,u). They arise indirectly through unitarity. Their presence is deduced from the existence of a perturbation graph that satisfies the Mandelstam representation with spectral boundary curves having asymptotes other than the normal threshold lines. (auth)

26344 PERTURBATION THEORY OF SCATTERING AMPLITUDES AT HIGH ENERGIES. James D. Bjorken and Tai Tsun Wu (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 130: 2566-72(June 15, 1963).

The asymptotic behavior of Feynman-Dyson graphs for elastic scattering at high energies is studied by means of the Mellin transform. The leading terms of a set of graphs involving three-particle intermediate states are summed. Under certain conditions the asymptotic behavior of the sum is found to contain a factor $(\ln s)^{-\frac{1}{2}}$. This is incompatible with Regge behavior, but is consistent instead with a cut in the complex angular momentum plane. (auth)

26345 SINGULARITIES IN THE UNPHYSICAL SHEETS AND THE ISOBAR MODEL. Rudolf C. Hwa (Univ. of California, Berkeley). Phys. Rev., 130: 2580-92(June 15, 1963).

Scattering amplitudes involving two- and three-particle states are continued across the inelastic section of the unitarity cut, and the singularities in the unphysical sheets thus reached are determined. Associated with an unstable particle is a complex unitarity cut, through which another unphysical sheet is reached. Dynamical singularities with a Born-type diagram for the three-particle scattering amplitude are found to be present in the elastic scattering and the production amplitudes also because of the coupling by unitarity. These singularities are isolated from the physical region by the complex unitarity cut and thus cannot be directly responsible for any resonance phenomenon. However, if the interaction force is favorable, a resonance pole can occur in a different Riemann sheet in the vicinity of these singularities. This resonance pole is directly accessible from the physical region and can therefore give rise to a resonance. (auth)

26346 DISPERSIVE TREATMENT OF WEAK DECAYS AND FINAL-STATE INTERACTIONS IN MODEL THEORIES. Kurt Haller (New York Univ., New York) and Leon F. Landovitz. Phys. Rev., 130: 2593-2600(June 15, 1963).

A model, in which a heavy fermion B is added to the Lee model and weakly coupled to V and θ is considered. Decay amplitudes for $B \rightarrow V + \theta$ and $B \rightarrow N + \theta + \theta$ are evaluated by dispersion theoretic methods. The absorptive part of these amplitudes incorporate contributions from one- and two-boson intermediate states. Attention is focused on the question of how well founded is the usual approximate treatment of absorptive amplitudes, which neglects the higher mass states with respect to the lowest mass states. It is shown that in a dispersion scheme that involves sufficient subtraction to give completely finite results, and that in-

volves as many arbitrary constants as the theory allows, the one-particle contributions to the absorptive parts of the $B \rightarrow N + \theta + \theta'$ amplitude diverge logarithmically and that these logarithmic divergences are cancelled by the two-particle contributions to this amplitude. (auth)

26347 CALCULATION OF THE SCATTERING CONSTANT FROM THE THEORY OF MULTIPLE SCATTERING. B. P. Nigam (Univ. of Buffalo). Phys. Rev., 131. 238-44 (July 1, 1963).

The expressions for the mean spatial and projected angles of multiple scattering are obtained using the distribution function for multiple scattering derived by Nigam, Sundaresan and Wu, and compared with those of Molière. It is shown that Molière's calculations involve the approximation of $\chi_c\sqrt{B} \rightarrow 0$. The distribution function of Nigam et al. is found to give correction terms that are proportional to powers of $\chi_c\sqrt{B}$ and $\chi_c\sqrt{B}\ \ln(\pi/\chi_c\sqrt{B})$. (auth)

26348 TWO-PION-EXCHANGE CONTRIBUTION TO THE Λ-NUCLEON SCATTERING MATRIX. R. Schrils and B. W. Downs (Univ. of Colorado, Boulder). Phys. Rev., 131: 390-6(July 1, 1963).

The two-pion-exchange (TPE) contribution to the Λ-nucleon scattering matrix was calculated with the Dyson S-matrix formalism under the assumption of even $\Lambda-\Sigma$ parity and a universal pion-baryon interaction. This calculation leads to a TPE contribution to the zero-energy Λ-nucleon scattering length that is spin-independent. For scattering at finite energies, the scattering matrix is spin-dependent and contains an anti-symmetric spin-orbit term, that does not appear in the charge-symmetric nucleon-nucleon scattering matrix. The results suggest the use of a semiphenomenological Λ-nucleon potential that, for large separations, is predominantly spin-independent. (auth)

26349 NEW SERIES FOR PHASE SHIFT IN POTENTIAL SCATTERING. S. Rosendorff (Univ. of Rochester, N. Y.) and S. Tani. Phys. Rev., 131: 396-406(July 1, 1963). (NYO-10256)

A new series for the phase shift was derived for the Schrödinger, Klein-Gordon, and Dirac equations. This series converges faster than the Born series for the tangent of the phase shift. This is so because the sum of the first n terms in the new series includes exactly all the terms up to the $2(2^n-1)$th order in the Born series. Under the condition that is tantamount to that the phase shift cannot be larger than 63°, the series converges absolutely. At high energies the series can be analytically continued with respect to the strength of the potential beyond such a limit. It is shown that the high-energy limit of the phase shift is given by its first Born approximation and that the difference between even and noneven potentials is reflected in the respective phase shifts to all orders. (auth)

26350 OPENING ANGLES OF ELECTRON-POSITRON PAIRS. Haakon Olsen (Norges Tekniske Hogskole, Trondheim, Norway). Phys. Rev., 131: 406-15(July 1, 1963).

The cross section for production of a high-energy electron-positron pair of opening angle θ and electron energy ϵ_1, $d^2\sigma(\theta,\epsilon_1)/d\theta d\epsilon_1$ is calculated. Comparison with available experimental data shows good agreement with the present theory. The cross section $d^2\sigma(\theta,\epsilon_1)/d\theta d\epsilon_1$ is shown to be closely related to the cross section for an angle θ_1 between the photon and the electron, $d^2\sigma(\theta_1,\epsilon_1)/d\theta_1 d\epsilon_1$. At high photon energies the functional dependence of $d^2\sigma(\theta,\epsilon_1)/d\theta d\epsilon_1$ on the variable $w = (\epsilon_1\epsilon_2/k)\theta$ is very nearly the same as the functional dependence of $d^2\sigma(\theta_1,\epsilon_1)/d\theta d\epsilon_1$ on the variable $u = \epsilon_1\theta_1$. The experimental method of estimating the energy of a photon creating a pair from the opening angle of the pair is discussed. Formulas for the most probable photon energy for a measured opening angle, including the effect of multiple scattering, are given. (auth)

26351 VARIATIONAL PRINCIPLES FOR ELECTROMAGNETIC POTENTIAL SCATTERING. R. J. Wagner (Space Tech. Labs., Inc., Redondo Beach, Calif.). Phys. Rev., 131: 423-34(July 1, 1963).

Variational methods are considered for the solution of the vector wave equation describing the field due to an arbitrary source placed in the neighborhood of an inhomogeneous absorbing medium. Variational principles for the tensor Green's function satisfying the point source equation were obtained in linear and exponential forms, analogous to the Altshuler principles for the scalar wave function. Stationary forms for the wave function and the scattering amplitude in the standard scattering problem are recovered when the point source recedes to infinity. For the special case of a spherically symmetric scatterer, the analysis leads to variational principles for the two independent lth-order phase shifts. The method is illustrated by a calculation of the fields internal to an axially symmetric potential. (auth)

26352 QUASIPARTICLES AND THE BORN SERIES. Steven Weinberg (Univ. of California, Berkeley). Phys. Rev., 131: 440-60(July 1, 1963).

Perturbation theory always works in nonrelativistic scattering theory, unless composite particles are present. By composite particle is meant a bound state or resonance, or one that would exist for an interaction of opposite sign; in fact, this provides a precise definition of resonances. It follows that if fictitious elementary particles are first introduced to take the place of all composite particles, then perturbation theory can always be used. There are several ways of accomplishing this, one of which corresponds to the N/D method. In order to prove these results it is necessary to make a detailed study of the eigenvalues of the scattering kernel, and as a by-product new proofs of the applicability of the Fredholm theorems to scattering theory, of the convergence of the Born series at high energy, of the Bargmann-Schwinger theorem on the number of bound states, of the Pais-Jost theorem on the identity of the Jost function with the Fredholm determinant, and of Levinson's theorem are obtained. Explicit formulas for binding energies and phase shifts in potential theory are given, using first-order perturbation theory after insertion of a single quasiparticle; these formulas work well for the lowest bound state and the S-wave scattering length of the Yukawa potential, and give precisely 13.6 ev for the hydrogen atom binding energy. (auth)

26353 EFFECT OF OVERLAPPING RESONANCES IN FINAL STATES. P. K. Srivastava (Univ. of Chicago). Phys. Rev., 131: 461-70(July 1, 1963). (EFINS-62-67)

By introducing an $N\theta$ scattering resonance, the $V\theta$, $N\theta\theta$ sector of the Lee model provides a calculable model for reaction processes leading to a three-particle final state where two overlapping resonances can occur. The $V\theta$ scattering and reaction cross sections calculated are found to be free of any bump in the energy range corresponding to overlap of the two final $N\theta$ resonances. The $V\theta$ scattering amplitude is analytically continued to higher Riemann sheets, and the singularity analogous to that conjectured by Peierls to be the cause of higher resonances in the pion-nucleon system was shown to lie on a Riemann

sheet far from the physical domain. These results cast considerable doubt on the validity of this proposed mechanism for the production of higher resonances. (auth)

26354 INTERACTION ENERGY IN GEOMETROSTATICS. Dieter R. Brill (Yale Univ., New Haven) and Richard W. Lindquist. Phys. Rev., 131: 471-6(July 1, 1963).

The geometrodynamical description of particles by means of topological features of empty space-time is applied here to the case of N charged masses that are momentarily at rest. These particles are represented by Einstein-Rosen bridges in a manifold that satisfies the time-symmetric initial value equations of gravitation and electromagnetism. Invariant definitions are given for the total mass energy of the system, and for the bare mass of each Einstein-Rosen bridge. These masses characterize various asymptotically Schwarzschildian regions of the manifold and are, therefore, conserved in time. The total mass of the system differs from the sum of the bare masses by contributions from the gravitational and electrostatic interaction energies. It is shown that the interaction energy is always negative, and that it reduces to the classical expression in the limit of large separation between the masses. The shape of the minimal surface associated with each Einstein-Rosen bridge, another invariant feature of the particle, is discussed. The minimal surfaces are also used to characterize manifolds that can be interpreted as a closed universe containing N + 1 particles. (auth)

26355 HIGH-ENERGY BEHAVIOR OF FEYNMAN AMPLITUDES. George Tiktopoulos (Univ. of Chicago). Phys. Rev., 131: 480-90(July 1, 1963).

A method is developed for obtaining the asymptotic form of the Feynman integral associated with a general convergent nth order planar graph with two, three, or four external lines. Only graphs corresponding to the $\lambda\phi^3$ theory are considered explicitly. The Feynman integrals are shown to behave asymptotically like $s^{-\rho}(\ln s)^{\alpha}$, where s is the large kinematical variable and ρ and α are integers that can be read off from the topology of the graph according to a simple rule. (auth)

26356 SOME EXPERIMENTAL CONSEQUENCES OF REGGE POLES. William R. Frazer (Univ. of California, San Diego). Phys. Rev., 131: 491-4(July 1, 1963).

The prediction of the Regge pole hypothesis concerning the ratio of real to imaginary part of the forward scattering amplitude is pointed out, and the question of how high an energy is required to test this prediction is investigated. (auth)

26357 CLASSICAL RADIATION RECOIL. [PART] II. Thomas A. Morgan and Asher Peres (Syracuse Univ., N. Y.). Phys. Rev., 131: 494(July 1, 1963).

The angular momentum carried off by electromagnetic or gravitational waves is evaluated by computing the torque exerted by the radiation on the emitting system. The lowest order secular effect in the electromagnetic case is proportional to the vector product of the first and second time derivatives of the electric dipole. In the gravitational case, the lowest order term is proportional to the antisymmetrized product of the second and third time derivatives of the mass quadrupole. (auth)

26358 TECHNIQUE FOR ELIMINATING INTERFERENCE EFFECTS AND BIASES FROM OVERLAPPING RESONANCES. Philippe Eberhard and Morris Pripstein (Collége de France, Paris). Phys. Rev. Letters, 10: 351-3(Apr. 15, 1963).

Biases that arise from the usual assumptions made in treating reactions with three particles in the final state where two overlapping resonances occur are described, and a technique for eliminating these biases is demonstrated. (D.C.W.)

26359 ISOBAR MODEL ANALYSIS OF SINGLE PION PRODUCTION IN PION-NUCLEON COLLISIONS BELOW 1 Bev. M. Olsson and G. B. Yodh (Univ. of Maryland, College Park). Phys. Rev. Letters, 10: 353-7(Apr. 15, 1963).

The isobar model of Bergia, Bonsignori, and Stanghellini for single π production in π-N collisions is shown to account for the majority of the observed mass spectra and the ratio of π^0 to π^+ production in π^+-p collisions from 350 Mev to 1 Bev when the p-wave decay of the isobar and requirements of Bose statistics are included. Predictions of this improved model are compared with experimental data and with the predictions of other models. (D.C.W.)

26360 THEORY OF SCATTERING WITH LARGE MOMENTUM TRANSFER. Robert Serber (Columbia Univ., New York). Phys. Rev. Letters, 10: 357-60(Apr. 15, 1963).

Measurements of elastic p-p scattering for high momentum transfers are noted to follow a simple power law, and it is shown that this law can be understood in terms of an optical model in which the medium is taken to be purely absorptive and to be spatially distributed according to a Yukawa function. (auth)

26361 VERIFICATION OF THE TENFOLD ASSIGNMENT OF THE BARYON RESONANCES. S. Meshkov (National Bureau of Standards, Washington, D. C.), C. A. Levinson, and H. J. Lipkin. Phys. Rev. Letters, 10: 361-4(Apr. 15, 1963).

Relations by which the validity of the assignment of the baryon resonances to the (30) representation of SU_3 can be tested are derived. The processes meson + baryon → baryon resonance + vector meson and meson + baryon → baryon resonance + meson are examined; and relations between differential cross sections, branching ratios, and scattering amplitudes are developed. (D.C.W.)

26362 QUANTUM NUMBERS OF A 1020-Mev $K\overline{K}$ RESONANCE. P. Schlein, W. E. Slater, L. T. Smith, D. H. Stork, and H. K. Ticho (Univ. of California, Los Angeles). Phys. Rev. Letters, 10: 368-71(Apr. 15, 1963).

The reactions $K^- + p \rightarrow \Lambda + K^+ + K^-$ and $K^- + p \rightarrow \Lambda + K^0 + \overline{K}^0$ were studied at incident K^- momenta of 1.95 Bev/c and 1.80 and 1.95 Bev/c, respectively. Analysis of the data indicates a maximum width for the observed 1.02-Bev resonance of 5 Bev and a quantum number of I = 0, $J^{PC} = 1^{--}$. These values agree with those Sakurai proposed for a vector meson called φ. (D.C.W.)

26363 EXISTENCE AND PROPERTIES OF THE φ MESON. P. L. Connolly (Brookhaven National Lab., Upton, N. Y.), E. L. Hart, K. W. Lai, et al. Phys. Rev. Letters, 10: 371-6(Apr. 15, 1963).

Analysis of data from a study of the K^--p reaction at 2.23 Bev/c confirms the existence of a resonance at about 1.02 Mev and shows that the resonance has M = 1.019 ± 1 Bev, $\Gamma = 1^{+3}_{-1}$ (with $\Gamma > 0$), parity (P) = −1, spin (J) = 1, isotopic spin (I) = 0, and charge conjugation (C) = −1. (D.C.W.)

26364 7- TO 20-Bev/c π^- + p AND p + p ELASTIC SCATTERING AND REGGE POLE PREDICTIONS. K. J. Foley, S. J. Lindenbaum, W. A. Love, S. Ozaki, J. J. Russell, and L. C. L. Yuan (Brookhaven National Lab.,

Upton, N. Y.). (Phys. Rev. Letters, 10: 376-81(Apr. 15, 1963).

Elastic differential cross sections for p-p and π^--p scattering in the incident momentum ranges 7 to 20 and 7 to 17 Bev/c, respectively, were measured. Analysis of the data in terms of vacuum pole dominance showed the p-p cross section to have the shrinkage predicted by Regge pole theory while the π^--p cross section showed no shrinkage. The results are also related to the three-pole model. (D.C.W.)

26365 LEPTONIC DECAY OF THE Ξ^- HYPERON. D. Duane Carmony and Gerald M. Pjerrou (Univ. of California, Los Angeles). Phys. Rev. Letters, 10: 381-4 (Apr. 15, 1963).

The decay of a Ξ^- hyperon, produced in the reaction $K^- + p \rightarrow \Xi^- + \pi^+ + \bar{K}^0$, by the mode $\Xi^- \rightarrow \Lambda + e^- + \bar{\nu}$ is reported; and a most probable value of 0.6% is determined for the branching ratio of this decay. (D.C.W.)

26366 REGGE POLES IN RENORMALIZABLE FIELD THEORIES. P. Budini (Università, Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Phys. Rev. Letters, 10: 384-6(Apr. 15, 1963).

The renormalization group that has been used to obtain the Regge behavior of the scattering amplitudes at high energy is shown to give a necessary condition for the existence of Regge type solutions in renormalizable theories. (D.C.W.)

26367 DETERMINATION OF THE RELATIVE Σ-Λ PARITY. H. Courant (CERN, Geneva), H. Filthuth, P. Franzini, et al. Phys. Rev. Letters, 10: 409-12 (May 1, 1963).

The invariant mass spectrum of Dalitz pairs from the decay of unpolarized hyperons (Σ^0), $\Sigma_0 \rightarrow \Lambda^0 + e^- + e^+$, was measured to determine the relative Σ-Λ parity. The decay was established as a magnetic dipole transition that indicates an even Σ-Λ parity. (C.E.S.)

26368 NEGATIVE PION-PROTON ELASTIC SCATTERING AT 10 Gev/c. S. Brandt (CERN, Geneva), V. T. Cocconi, D. R. O. Morrison, A. Wroblewski, P. Fleury, G. Kayas, F. Muller, and C. Pelletier. Phys. Rev. Letters, 10: 413-15(May 1, 1963).

The results of elastic scattering of mesons (π^-) on protons at 10 Bev/c show that the shrinkage of the diffraction peak between 3 and 10 Bev/c is much smaller than that observed for proton-proton scattering. The differential cross section at small momentum transfer deviates from the exponential shape usually assumed, presenting an upward curvature. This, if confirmed, requires a revision in the intepretation of elastic scattering data at high energies. (C.E.S.)

26369 DOES THE f^0 PARTICLE LIE ON THE POMERANCHUK TRAJECTORY? Alberto Pignotti (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 416-20 (May 1, 1963). (UCRL-10600(Rev.))

By means of current theories on Regge trajectories it is shown that the f^0 particle, which is a π-π resonance state at 1250 Mev with I = 0 and J = 2, can be interpreted in terms of the Pomeranchuk trajectory. (C.E.S.)

26370 CROSSING-SYMMETRIC WATSON-SOMMERFELD TRANSFORMATION. N. N. Khuri (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 10: 420-3(May 1, 1963).

The derivation of a crossing-symmetric Watson-Sommerfeld transformation that simultaneously displays the contributions of Regge poles in all three channels is presented. An analysis that attempts to free Regge poles from their strict attachment to angular momentum and Legendre expansions is used. (C.E.S.)

26371 RELATIVE WEIGHTS OF THE DECAYS OF CERTAIN RESONANCES IN THEORIES WITH BROKEN SYMMETRY. C. Dullemond (Univ. of Washington, Seattle), A. J. Macfarlane, and E. C. G. Sudarshan. Phys. Rev. Letters, 10: 423-5(May 1, 1963). (NYO-10260)

Relations between the relative weights of the decays of various resonances into baryon-meson states in the Ne'eman–Gell-Mann theory of strong interactions when exact invariance under SU_3 suffers a first-order perturbation by interactions invariant under only isospin and strangeness transformations are derived. Resonances associated with the irreducible representation of SU_3 with highest weight (3,0) are used. The decays of N^*, Y_1^*, Ξ^*, and Ω are illustrated. (C.E.S.)

26372 MEASUREMENT OF THE DEPOLARIZATION PARAMETER FOR 50-Mev PROTON-PROTON SCATTERING AT 70° c.m. T. C. Griffith, D. C. Imrie, G. J. Lush, and A. J. Metheringham (Univ. of London). Phys. Rev. Letters, 10: 444-6(May 15, 1963).

The depolarization parameter for 50-Mev proton-proton scattering was measured to determine the $^3P_0$ phase shift to considerably high accuracy. The depolarization parameter is highly sensitive to this $^3P_0$ phase shift. Using the well-defined geometry of the scattering system and information on cross sections and polarization in proton-helium scattering at energies below 30 Mev, a Monte Carlo calculation of $^3P_0$ yielded the value of -0.476 ± 0.020 and a depolarization parameter of -0.249 ± 0.075. (C.E.S.)

26373 REMARKS ON THE MULTIPLET STRUCTURE OF STRONG INTERACTION SYMMETRY. J. J. Sakurai (Univ. of Chicago). Phys. Rev. Letters, 10: 446-8(May 15, 1963).

The problem of inferring the correct symmetry group in strong interaction symmetry once the patterns of supermultiplets are determined is discussed. The Yukawa-type coupling of the (π^+, π^-, π^0) triplet to the (p,n) doublet and the Yukawa-type interactions of mesons (π^+), (π^-), and (π^0) with the baryons p, n, and hyperons (Λ), (Σ^+), (Σ^-), (Σ^0), (Ξ^0), and (Ξ^-) are considered. The mutual interaction between the degenerate vector-meson octet and degenerate pseudoscalar meson octet is compatible only with SU_3 symmetry. (C.E.S.)

26374 USE OF THE DEUTERON TO PROVIDE A POLARIZED PROTON TARGET. Stephen L. Adler and Alfred S. Goldhaber (Princeton Univ., N. J.). Phys. Rev. Letters, 10: 448-50(May 15, 1963).

It is shown that deuterons can be used to provide a polarized proton target for experiments in the Bev range. The deuteron consists of a neutron and proton with their spins correlated in a triplet state. In certain reactions only the proton takes part, while the neutron stands by as a spectator. The nucleon spin correlation implies that a measurement of the neutron polarization gives information about the proton polarization. Proton polarizations up to a maximum of $\frac{1}{3}$ can be obtained. (C.E.S.)

26375 DIFFRACTION SCATTERING. Peter G. O. Freund and Reinhard Oehme (Univ. of Chicago). Phys. Rev. Letters, 10: 450-3(May 15, 1963).

A theorem concerning the absence of fixed Regge poles and a large class of other fixed singularities in the complex angular momentum plane is discussed in relation to diffraction scattering of mesons(π^-) on protons. Models are

proposed that give shrinking and nonshrinking diffraction patterns for different reactions, and their experimental consequences are discussed. (C.E.S.)

26376 EVIDENCE FOR A TWO-PION DECAY MODE OF THE ω MESON. W. J. Fickinger, D. K. Robinson, and E. O. Salant (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 10: 457-60(May 15, 1963).

A 2-π decay mode of the meson(ω) is inferred from the effective-mass distribution of the two mesons(π) produced in the reaction $\pi^- + p \rightarrow n + \pi^- + \pi^+$ at an incident momentum of 1.7 Bev/c. When the events of the reaction are analyzed as a function of momentum transfer to the nucleon, a statistically significant number of events fall in a narrow band peaked at a mass close to the mass of the meson(ω). Most events fall in the meson(ρ) resonance band indicating both meson(ω) and (ρ) intermediate states in the reaction. Properties of the meson(ω) and (ρ) are also summarized. (C.E.S.)

26377 NEW UPPER BOUND FOR THE HIGH-ENERGY SCATTERING AMPLITUDE AT FIXED ANGLE. T. Kinoshita, J. J. Loeffel, and A. Martin (CERN, Geneva). Phys. Rev. Letters, 10: 460-2(May 15, 1963).

It is shown that if the scattering amplitude is analytic and uniformly bounded by a power of the square of the total energy, the upper bound for the high-energy scattering amplitude at a fixed angle can be improved. (C.E.S.)

26378 MOTION OF A RELATIVISTIC CHARGED PARTICLE. [PART] II. I. Prigogine and F. Henin (Université Libre, Brussels). Physica, 29: 286-92(Apr. 1963). (In English)

The significance and consequences of the relativistic generalization of the Sommerfeld theory of the extended electron are discussed. The study is based on the one-dimensional motion of a charged particle. The essential point is that the effective form factor that appears in the equation of motion of the particle is equivalent to a functional of the motion. Motion and structure thus seem to be strongly coupled. This type of coupling is not found in the simple limiting case of the rigid-particle model, which fails to account for the "deformability" of the particle in the high-energy region. It is this deformability that produces the nonlinear characteristics of the particle. For example, in the case of a constant external force field, the rigid-particle model requires a mass that decreases with acceleration. (tr-auth)

26379 ELECTRON CAPTURE FROM HELIUM BY FAST PROTONS. B. H. Bransden and I. M. Cheshire (Univ. of Glasgow). Proc. Phys. Soc. (London), 81: 820-31(May 1, 1963).

The impulse approximation is used to calculate the cross section for the reaction $H^+ + He(1s^2) \rightarrow H(1s) + He^+(1s)$, for the range of incident proton energies 25 kev to 1 Mev. The results are compared with those given by Mapleton in 1961 using the Born approximation and are found to differ significantly especially in the predicted angular distributions. By estimating the probability for capture into excited states the total capture cross section is calculated and found to be in fair agreement with experimental results. (auth)

26380 TRAJECTORY TRACER FOR CHARGED PARTICLES WHICH INCLUDES MAGNETIC FIELDS AND SPACE CHARGE. T. Van Duzer (Univ. of California, Berkeley), C. R. Buckey, and G. R. Brewer. Rev. Sci. Instr., 34: 558-67(May 1963).

Theory and design are presented of an analog system for computing trajectories of charged particles in electron and ion guns, where the effects of space charge and magnetic fields are important. Two electrolytic tanks are used for simulation of the total electrostatic and magnetic fields. The wedge-shaped tank used for simulation of the electrostatic fields in axial symmetry contains current sources in the forms of wire probes and inlaid resistive plugs for the introduction of space-charge effects. The magnetic fields to be considered satisfy Laplace's equation and are simulated by specifying boundary conditions on the magnetic scalar potential. A special tank for obtaining accurate results on a thin annular beam is described. A precision analog computer solves the equations of motion with the fields measured in the tanks and controls the servomechanisms which move the field-sampling probes along the trajectory. Some results for high-perveance electron guns are compared with beam sampling measurements on actual guns. (auth)

26381 QUASIOPTICAL MODEL AND ASYMPTOTIC OF SCATTERING AMPLITUDE. B. A. Arbuzov, A. A. Logunov, A. H. Tavkhelidze, R. N. Faustov, and A. T. Filippov (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 1409-11(Apr. 1963). (In Russian)

A Schroedinger type equation, with generalized complex potential, for describing two-particle quantum field theory can be used to find the scattering matrix and to study the structure of bound and resonance states (virtual processes). An attempt was made to describe only the relativistic scattering matrix, where generalized potential is a function of the energy and momentum transfer. (R.V.J.)

26382 TOTAL CROSS SECTIONS FOR NEUTRON-NEUTRON INTERACTIONS AT 8.3 Bev. M. N. Khachaturyan and V. S. Pantuev (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 1411-12 (Apr. 1963). (In Russian)

The total cross section for neutron-neutron interactions was measured by various methods using 50.1 and 55.60 g/cm^2 thick H_2O and D_2O targets. The result for an effective energy of ~8.3 Bev was $\sigma_{nn} = 31.5 \pm 1.7$ mb. According to Lindenbaum et al. (Phys. Rev. Let., 7: 185(1961)), within the limits of error the $\sigma_t(pp) = 39.5 \pm 1$ mb. Substituting the experimental magnitudes of total cross sections σ_{pp} and σ_{nn}, shielding corrections, $\delta\sigma = 39.5$ to 31.5 ± 8 mb, are in good agreement with 7.2 mb obtained by Glauber (Phys. Rev. Let., 100: 242(1955)) for $v(r) \sim \lambda(e^{\lambda r} - 1)^{-1}$ potential. (R.V.J.)

26383 A VELOCITY-DEPENDENT p-p POTENTIAL MODEL. Charles Ray Dismukes. Thesis, Los Angeles, Univ. of California, 1963. 124p.

A velocity-dependent potential, with a well-behaved radial dependence, can give a fairly good account of the energy dependence of the singlet-even-parity proton-proton phase shifts. The possibility of describing the entire p-p interaction with a velocity-dependent potential model is investigated. The simplest explicitly velocity-dependent interaction $V(r, \bar{P}^2)$, one which depends quadratically on $\bar{P}$, the relative momentum of the two protons, is considered. The one-pion exchange potential is included in the model in such a way that it gives no contribution at $r = 0$, but dominates the interaction at large r. The treatment is nonrelativistic and Coulomb effects are included exactly. The p-p scattering phase shifts were obtained by numerical integration of the Schroedinger equation containing the interaction described above. Some improvement over previously obtained singlet-even phase shifts is found. The high energy decrease of the ^1D phase shift cannot be completely eliminated within the framework of the assumptions. The ^1S

phase shift and the low-energy parameters are described accurately. Very good fits for the triplet-odd phase shifts are obtained. The resulting velocity-dependent potential model gives predictions for the p-p phase shifts which are as good as, or better than, those obtained with static hard-core models. Thus p-p scattering data alone are insufficient to distinguish between the two types of models. The velocity-dependent model obtained is a well-behaved, phenomenologically valid p-p interaction, which can be used to calculate the properties of many-nucleon systems by means of perturbation theory. (Dissertation Abstr.)

26384 POSITRON LIFETIME STUDIES IN SOLIDS AND LIQUIDS. Robert Lyle Dough. Thesis, Raleigh, N. C., North Carolina State Coll., 1962. 81p.

The millimicrosecond lifetime of Na^{22} positrons has been measured in various solids and liquids. The measuring system employed a time-to-pulse-height converter and a multichannel analyzer and was used with a resolving time of 1.7 mμsec. The calculations for the lifetime and the intensity were made on the IBM 650 computer. The τ_2 lifetimes (in mμsec) in 8 different classes of commercial plastics were: Teflon, 3.93; poly-FEP, 3.58; polyethylene, 2.66; polypropylene, 2.15; polycarbonate (Lexan), 2.13; polystyrene, 2.13; Lucite, 2.02; nylon (Zytel), 1.67; and polyester (Vibrin), 1.44. From comparison with other properties, the best correlation of the lifetime is with the electrical resistivity. The results for samples of Teflon, poly-FEP, and polyethylene, which were each characterized by 3 different degrees of crystallinity, show that the τ_2 intensity–degree of crystallinity curve has a slope of ~0.30%/%. There may possibly be a slight decrease in the lifetime curve but the results were not conclusive. Other results show that the presence of a phenyl group usually results in a large τ_2 intensity. It has been indicated that the multichannel method is more accurate than the single-channel method, especially for measurements of the τ_2 intensity. (Dissertation Abstr.)

26385 PROTON-PROTON COLLISIONS AT 30.0 Bev. Edward Robert Goza, Jr. Thesis, Seattle, Univ. of Washington, 1962. 119p.

The magnetically analyzed external, diffracted proton beam of the Brookhaven Alternating Gradient Synchrotron, AGS, was used to expose a stack of Ilford G-5 emulsion plates to 30.0 Bev protons. The energy distribution of the incident protons was analyzed experimentally (using an unbiased sample of 80 incident proton tracks) and compared to two theoretical distributions. The theoretical distributions were obtained by a random number process and also by a convolution process, both using the distribution of second differences as obtained from the Molière theory of multiple scattering. Of the 1354 interactions located in a distance of 484.0 meters (by on track scanning), 10 events were found to meet the selection criteria for elastic events, yielding an elastic cross section of 6.5 ± 2.1 mb. In addition, 16 elastic events were located by area scanning, and the total number of 26 elastic events was compared to the uniform optical model. The center of mass system angular distribution of elastically scattered protons did not seem to be in too good an agreement with the optical model for a purely absorbing proton. A total of 106 even prong inelastic events was found, of which about 50% were attributed to be proton-free-proton collisions, yielding an inelastic cross section of 34.2 ± 4.8 mb. The inelastic collisions were examined using multiple scattering, grain density, range, and angle measurements; and they were compared to Hagedorn's statistical theory calculations made at 25 Bev. Over-all agreement was not too good; however, the average kinetic energy of identified pions, K-mesons, and protons is in fairly good agreement, as is the charged pion multiplicity and over-all charged particle multiplicity. (Dissertation Abstr. 23: May 1963)

26386 A STUDY, BY MEANS OF A PSEUDOSCALAR LEE MODEL WITH PAIRS, OF SOME OF THE APPROXIMATIONS USED IN COMPUTATION OF THE NUCLEON'S ELECTROMAGNETIC PROPERTIES. David Larry Fried. Thesis, New Brunswick, N. J., Rutgers Univ., 1962. 133p.

A cut-off version of the Lee model was developed which simulates the nucleon-pi meson interaction and contains the possibility of pair production. The particles are charged in the manner of the nucleon and meson. An exact solution simulating the nucleon eigenstate was obtained. Operators for the electromagnetic properties were developed and evaluated for the eigenstate. Some of the approximations used in computations of the nucleon's electromagnetic properties are introduced and their effect is evaluated. The results suggest the following: pair production is not significant, in terms of electromagnetic properties, in a cut-off theory; certain aspects of the static model were significantly misunderstood; wave function renormalization, ignored in some computations, plays a significant part in determining the results; and an approximation, accurate only to the lowest order in momentum over mass, appears to be as accurate as an approximation containing the first two orders, i.e., only accurate to within a factor of 2. (Dissertation Abstr. 23: May 1963).

26387 LOCALIZED PARTICLE DESCRIPTION OF A SYSTEM OF FERMIONS. Loren Eugene Radford. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 45p.

The single-particle approximation was employed in the solution of a system of N particles. The starting equations in this investigation are the one-particle equations of Hartree. The conditions assumed for the system of N particles are: the system consists of fermions distributed with uniform density, a repulsive interaction between particles exists, and a uniform background potential sufficient to keep the system in equilibrium is present. The resulting one particle wave functions are solutions of the equation $[(-\hbar^2\nabla^2)/2m) - \int|\psi(\underline{r}')|^2\, v(\underline{r} - \underline{r}')\, d\underline{r}' - E]\,\psi(\underline{r}) = 0$ and are localized in space. The validity of this method depends upon whether the energy of the system so described is lower than that obtained with plane wave solutions. A self-consistent solution of the one-particle equation was determined by numerical methods assuming Yukawa and Coulomb interaction potentials. The energy of the system was determined from the variational principle. Applications to the cases of nucleons (Yukawa interaction) and to the electron gas are considered. The localized one-particle equations do not have a bound state solution for nucleon potential parameters; however, solutions for fermions with longer range potential do exist. In particular for electrons the energy per particle is appreciably lower than in the free particle approximation. Energies were compared with the calculations of Wigner and Nozieres and Pines with similar behavior in the region of metallic densities observed. The method developed has the advantage of providing a correlation between particles irrespective of spin. The wave functions exhibited provide a reasonable zero-order approximation to the N particle system within certain limits of density and are, furthermore, devoid of difficulties encountered when plane waves are used as a zero order approximation. (Dissertation Abstr. 23: May 1963).

26388 GENERATION OF SUB-MILLIMETER RADIATION BY A BUNCHED BEAM OF RELATIVISTIC ELECTRONS. Pedro Americo Szente. Thesis, Stanford, Calif., Stanford Univ., 1962. 129p.

The interaction of a bunched beam of relativistic electrons with several different microwave circuits was analyzed, with a view toward the generation of electromagnetic radiation in the sub-millimeter wavelength region. Because of relativistic effects, it was possible to use structures which had dimensions large compared to the desired wavelength. A relativistic electron beam was obtained from a traveling-wave linear accelerator which operated at a frequency of 9288 Mc/sec. The interaction properties predicted by theory were compared with the experimental results obtained from resonant cavities, from a dielectric loaded slow-wave structure, and from two other special structures: a magnetic undulator and a sinuous waveguide. In the case of the magnetic undulator, approximately 150 Mw were generated at 5.4 mm, and 35 Mw at 1 mm. The shortest wavelength observed was 0.4 mm at a power level of 40 μw. The methods of power transmission and of measurement of wavelength and impedance used in this study were largely adapted to sub-millimeter wavelengths from optical techniques. Optical spectrometers and filters were used, as well as wavemeters and reflectometers that were modifications of optical interferometers. A square-law power detector was built by using a bolometer in a system that permitted the measurement of peak power at levels as low as tens of microwatts. Special crystals were also used as detectors. (Dissertation Abstr., 23: May 1963).

26389 ELECTROMAGNETIC STRUCTURE OF PIONS AND NUCLEONS. Cloyd Orris Beasley, Jr. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 49p.

An attempt was made to achieve a satisfactory explanation of the observed behavior of the nucleon electromagnetic structure, in particular, the isotopic vector form factor, $F_2^V(t)$. The approach of Frazer and Fulco (using the N/D method) which successfully explains this structure by means of an artificial pion-pion scattering resonance was extended analytically by the use of a CDD pole to include two resonances, the motive for this being that the one well-known pion-pion scattering resonance, the ρ, occurs at too high an energy to successfully explain $F_2^V(t)$. Calculations resulted in the particular type of D which contains a pole, rather than D_{0mnes} (which is the denominator of f = N/D when the pole is multiplied out). Results which satisfy the behavior of $F_2^V(t)$ were found, but a large low-energy pion-pion scattering resonance must be present to explain this. Results using the questionable ζ resonance can give $F_2^V(0)$, but not $F_2^V(t)$. Other parameters, the pion-pion scattering length and the charged-neutral pion mass difference, were calculated for the various choices of pion resonances. For the choice of D used, the scattering length turned out larger as the position of the second resonance was lowered; the pion mass difference, taken from a calculation of the lowest order Feynman diagram for the electromagnetic self-energy of the pion, turned out to be the right order of magnitude. (Dissertation Abstr. 23: May 1963)

Neutron Physics

Refer also to abstract 25680.

26390 (EUR-22.e) SPACE AND TIME DEPENDENT EIGENVALUE PROBLEM IN NEUTRON THERMALIZATION. H. Takahashi (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). Sept. 1962. 25p.

The matrix elements of the neutron scattering kernel for a free gas and a crystalline material expanded in terms of Laguerre polynomials of energy, weighted by a Maxwellian distribution, are obtained by a generating function for the Laguerre polynomial. The eigenvalue problems in a spatial and time dependent neutron thermalization are solved by using the obtained matrix element. For the spatial problem first order Laguerre polynomials are used. Half order Laguerre polynomials are used for the time dependent problem, because they diagonalize, respectively, the spatial and the time dependent term. (auth)

26391 (EUR-105.e) TERMIDOR—AN IBM 7090 FORTRAN CODE TO EVALUATE THE THERMAL NEUTRON SPECTRUM IN AN ORGEL TYPE FUEL ELEMENT. G. Rossi (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1962. 14p.

The general lines are presented of the simplified model adopted to evaluate the thermal neutron spectrum in an Orgel type fuel element. The flow chart of the code, the input and output data of the subroutines, which contain directly utilizable results, are given. (auth)

26392 (GA-3853) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending December 31, 1962. J. R. Beyster, J. R. Brown, G. K. Houghton, et al. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Feb. 11, 1963. Contract AT (04-3)-167. 74p.

Neutron spectrum measurements were made in poisoned zirconium hydride and benzene. The results were compared with theoretical calculations. The zirconium hydride spectra showed pronounced hardening and spectral shift with temperature. Very good experimental and theoretical agreement was obtained for the benzene spectra. Angular spectra were also calculated and measured for 1% borated polyethylene. Experimental and theoretical spectra obtained for the cadmium curtain experiment showed very good agreement at high energies, the lower energy agreement being somewhat reduced. Asymptotic spectra in graphite were calculated in the diffusion approximation for a free gas and for a crystalline scattering kernel. The latter displayed much distortion in agreement with the trapping effect predicted by de Saussure. The total cross section of water was measured up to 100 ev with an apparent accuracy of $\pm 1/2$%. A pressure vessel for measuring steady-state neutron spectra in poisoned water at high temperatures was built and tested. Experiments to determine the magnitude of room return in the shielded neutron cave where spectra are measured were made to explain why measured leakage spectra from one-dimensional water slabs are softer than transport theory predictions using DSN. Results showed the effect of room return to be small and in the wrong direction to explain the discrepancy. The sensitivity of the 16-m detector bank was re-evaluated; the effect of precollimator size upon neutron spectra and counting rate was studied; and collimation and shielding on the 50-m station were improved. Calculations of angular and scalar spectra for water poisoned with $1/\nu$ absorber, pure water, and multiplying assemblies were made. Results show that for nonmultiplying finite media DSN or GAPLSN (one-dimensional transport theory codes) can be used to calculate spectra in closer agreement with experiment than previously. For multiplying media, theory and experiment are nearly in agreement for both angular and scalar flux. Scattering of neutrons by polyethylene was studied. Better agreement was achieved between experi-

mental and theoretical spectra for borated polyethylene. Theoretical predictions of the scattering law $S(\alpha,\beta)$ for water were compared with experimental results. Generally good qualitative agreement was obtained, and decreasing the weight of the rotational degree of freedom improved the agreement. Relations for testing the neutron conservation of experimental spectra were also derived. (D.C.W.)

26393 (LAMS-2856) A GENERAL MONTE CARLO NEUTRONICS CODE. Robert R. Johnston (Los Alamos Scientific Lab., N. Mex.). Mar. 1, 1963. Contract W-7405-eng-36. 188p.

A general geometry Monte Carlo code suitable for neutron penetration problems is described. A detailed description of the preparation of a problem and a complete listing of the code are included. (auth)

26394 (LAMS-2883) STUDY OF FISSION NEUTRON SPECTRA WITH HIGH-ENERGY ACTIVATION DETECTORS. James A. Grundl (Los Alamos Scientific Lab., N. Mex.). Mar. 1963. Contract W-7405-eng-36. 169p.

The energy spectra of neutrons from the fission of U-235, U-233, and Pu-239 were studied with seven high-energy activation detectors covering the range 0.6 to 16 Mev. Interpretation is in terms of the Maxwellian spectral function $E^{1/2}\exp(-E/T)$. By means of a unique cavity arrangement within a moderator to obtain pure thermal-neutron-induced fission neutrons, the average energies of the three spectra are found to be in the ratios U-235:U-233:Pu-239 = (1):(1.016 ± 0.003):(1.039 ± 0.003). Differences between the normalized spectra are most pronounced at high energies as exemplified by the relative Pu-239:U-235 flux ratios 1.17 ± 0.013 for $6 < E <$ 11 Mev, and 1.35 ± 0.03 for $E > 11$ Mev. Comparable detector responses within unreflected critical assemblies of U-235, U-233, and Pu-239 metal are consistent with an increase of at least 2% in the average energy of the fission spectrum component of each assembly relative to the corresponding thermal-fission spectrum. This may be associated with the approximately 1.5 Mev average energy of the assembly neutrons inducing fission. Through extensive detector calibration, average detector cross section ratios or spectral indices are established for the U-235 fission spectrum. Uncertainties assigned, applicable to spectral analysis, do not include absolute cross section errors. Indices involving Cu-63(n,2n) show that the U-235 fission spectrum yields approximately 20% fewer neutrons above 11 Mev than predicted by the Maxwellian spectral function. Though all other independent indices fall within two error intervals, they consistently suggest that the observed spectrum is shifted to higher energies. The associated development of the activation detectors as a comprehensive tool for measuring distributed neutron spectra is described in detail. (auth)

26395 (PAN-101/IX) MEASUREMENT OF NEUTRON TEMPERATURE DISTRIBUTION IN A GRAPHITE STACK. Tadeusz Rzeszot and Eugeniusz Warda (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 8p.

A neutron beam of known neutron temperature from a horizontal channel of the EWA reactor was directed into the graphite stack with two dimensions fixed (cross section 90 × 150 cm), and the third one variable. Neutron temperature distribution in the graphite stack was determined along the neutron beam axis by the boron-filter method. (auth)

26396 (PAN-107/IX) DIFIGREC — THE MULTIGROUP TWO-DIMENSIONAL CRITICALITY CODE. Teresa Kulikowska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 16p.

A few-group two-dimensional critical code for the URAL-2 digital computer is described. The code makes possible the solution of the critical eigenvalue problems for few-group equations written in the P_1 consistent approximation in two geometries: x-y and r-z. The number of mesh points is 400, the number of different material zones changing from 1 to 5, and the number of energy groups from 1 to 5. (auth)

26397 (PAN-246) HIGH YIELD RADIO-FREQUENCY ION SOURCE FOR A FAST NEUTRON GENERATOR. J. Huczkowski, S. Łazarski, and Z. Radwański (Polish Academy of Sciences. Inst. of Nuclear Research, Krakow). Mar. 1963. 11p.

The ion source was constructed with the aim of using it in a fast neutron generator. The deuterons extracted from the source are focused and accelerated up to 250 kev in an accelerating tube, and then fall on a tritium target to generate fast neutrons due to the d + t reaction. The requirements to be fulfilled by a fast neutron generator ion source are as follows: large beam current, low gas consumption, large relative content of atomic ions and low power consumption. Generally, these requirements are fulfilled very well by an ion source in which the gas ionization is carried out by means of a high-frequency electromagnetic field owing to ring discharges in the quartz chamber. In these ion sources the most adequate ion beam extraction system is the Thoneman type canal-ray arrangement. Therefore an ion source of this type was developed, and the construction is the most successful one of several solutions tested previously. (auth)

26398 (PAN-403/IX) MEASUREMENTS OF NEUTRON DIFFUSION PARAMETERS IN WATER USING A FAST-CHOPPER. Zbigniew Ogrzewalski, Tadeusz Rzeszot, Eugeniusz Warda, and Andrzej Graffstein (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 12p.

Neutron diffusion parameters in water were measured using the fast chopper operating at one of the horizontal channels of the EWA reactor. The conditions in which the fast chopper may be used for neutron life time measurements in water were investigated. In general the results of the $\alpha = f(B^2)$ dependence for several sizes of water samples are consistent with the results obtained by other authors. The method used makes possible in some cases the pulsation of the thermal neutron beam that seems very promising because of the diminished neutron leakage during slowing-down in the moderator. (auth)

26399 (RAS-33) AN INVESTIGATION OF NEUTRON ATTENUATION BY CASTABLE POLYETHYLENE. J. Shapiro and W. D. Welte (General Dynamics Corp. Electric Boat Div., Groton, Conn.). Dec. 15, 1960. 72p.

Radiation attenuation measurements were made on unirradiated samples of castable polyethylene and on samples that were exposed to 10^7 rads of reactor and Cobalt 60 gamma radiation. An investigation was conducted on the effect of voids on fast neutron dose rates through shields. Gaps in shields were traversed with various detectors and a probing method utilizing a 5 curie Pu–Be neutron source and neutron scintillation survey meter was found suitable for the detection of voids in polyethylene shields. A soil moisture detection method based on the thermalization of neutrons was applied to the measurement of the hydrogen content of castable polyethylene samples and results were encouraging for use of the method in quality control of manufactured castable polyethylene shields. (auth)

26400 BOUNDARY CONDITIONS FOR SOLVING THE BOLTZMANN EQUATION IN PERIODIC LATTICES. G. Ya. Rumyantsev. At. Energ. (USSR), 14: 371-4(Apr. 1963). (In Russian)

A previously described method (Atomnaya Energ., 13: 556(1962) No. 2) of the diffusion approximation was further developed and applied for the exact solution of the Boltzmann transport equation. The results of this study of the transport equation involving heterogeneous periodic lattices made it possible to consider only a single cell; the partial solutions of the single-velocity Boltzmann equation were then used for deriving a generalized solution for the whole medium. In the solution of two-dimensional problems, advantage may be taken of certain simplifying conditions, assuming that all rectangular cells are squares and making use of an asymptotic nonhomogeneous solution. It is often sufficient to find only the effective macroscopic parameters of the homogenized medium. The effective macroscopic parameters of the neutron diffusion process must be determined at various angles to the axis of the lattice. (TTT)

26401 ENERGY DISTRIBUTION OF SCATTERED NEUTRONS IN WATER. V. A. Dulin, Yu. A. Kazanskii, and I. V. Shugar. At. Energ. (USSR), 14: 404-5(Apr. 1963). (In Russian)

The neutron energy spectrum in water was determined at distances ranging from 20 to 90 cm from about a 15-Mev neutron source which made use of the $H^3(H^2,n)He^4$ reaction with a D energy of 400 kev. The measurements were carried out in the direction of the D beam at infinite geometry, by means of a single-crystal fast neutron scintillation spectrometer. The amplitude distribution was determined with a 128-channel analyzer. The energy scale of the spectrometer was determined at low amplification by the amplitude distribution and at high amplification by the γ radiation of ThC″ (E_γ = 2.62 Mev), corresponding to a neutron energy of 6.1 Mev. The experimental data agreed well with the calculations; the differences are probably due to different original neutron energies. From the spectra the relaxation lengths of the 14- to 16-Mev neutrons were found to be 15.0 ± 0.8 and 14.7 ± 0.9 cm at 30 to 60 and 60 to 90 cm, respectively, agreeing well with B. I. Sinitsyn's measurements of the relaxation length, carried out by making use of the $Cu^{63}(n,2n)Cu^{62}$ reaction as indicator. (TTT)

26402 NEUTRON SPECTRUM OF A PLUTONIUM–BERYLLIUM SOURCE. M. Edward Anderson and William H. Bond, Jr. (Monsanto Research Corp., Miamisburg, Ohio). Nucl. Phys., 43: 330-8(May 1963). (In English)

The neutron spectrum of a plutonium-beryllium source was obtained with the use of nuclear emulsions. Intensity maxima exist at less than 1.0 and at 3.2, 4.7, 7.7, and 9.7 Mev. Maxima at 4.7, 7.7, and 9.7 Mev are well accounted for in a calculated spectrum. Those at less than 1.0 and at 3.2 Mev are partially explained. Comparison with other published spectra shows more low-energy neutrons for a source with 80 g of plutonium than for a source containing 13 g of plutonium. (auth)

26403 A NOTE ON A SIMPLE METHOD FOR ACCELERATION OF FINITE-DIFFERENCE GROUP-DIFFUSION CALCULATIONS. Melvin Tobias, David R. Vondy, and Tom B. Fowler (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 15: 98-9(Jan. 1963).

A simple calculational device was introduced into the EQUIPOISE-3 program for reducing the number of iterations for convergence from ~5000 to 70. The device forces a neutron balance between groups at each iteration. (D.L.C.)

26404 THE TRANSPORT APPROXIMATION OF THE ENERGY-DEPENDENT BOLTZMANN EQUATION. G. Rakavy and Yeivin (Hebrew Univ., Jerusalem). Nucl. Sci. Eng., 15: 158-60(Feb. 1963).

The transport approximation of the Boltzmann equation is generalized to cover the case of anisotropic scattering with energy degradation. It is shown that in such cases the approximation is a complicated integro-differential equation for the angular flux, which is still simpler to solve numerically than the original equation. (auth)

26405 CONVERGENCE IMPROVEMENT OF DISADVANTAGE FACTORS BY THE USE OF EVEN ORDER SPHERICAL HARMONICS APPROXIMATIONS. John O. Mingle (Kansas State Univ., Manhattan). Nucl. Sci. Eng., 15: 161-5(Feb. 1963).

The normal calculations of disadvantage factors in slab geometry are performed with the odd-order spherical harmonics approximations; however, by the use of the complementary even-order results in conjunction with these standard solutions, a more accurate answer can be quickly obtained. Since the even-order approximations give an apparent upper bound on the true answer, a combination of low odd and even-order solutions produces a counterconvergence effect which closely brackets the true disadvantage factor. In particular the theory of the P_4 calculation is presented along with various numerical parameter studies. (auth)

26406 A COMMENT ON THE COLLISION DENSITY AT EPITHERMAL ENERGIES. Coleridge A. Wilkins (Univ. of New South Wales, Kensington, Australia) and A. Keane. Nucl. Sci. Eng., 15: 229-32(Mar. 1963).

An explanation is given of an apparent discrepancy between two methods for determining the collision density at epithermal energies. This explanation is based on a result from renewal theory. (auth)

26407 A DISCUSSION OF THEORETICAL ANALYSES OF PROBE-INDUCED THERMAL FLUX PERTURBATIONS. R. K. Osborn (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 15: 245-58(Mar. 1963).

A review is presented of the theoretical task of interpreting the measurement of a thermal neutron absorption rate in terms of the neutron density that existed at the probe location prior to probe insertion. Successful accomplishment of this task is fairly obviously of considerable practical importance, since activation measurements of thermal fluxes are an important adjunct to many reactor experiments and are also frequently employed to obtain thermal flux maps in reactor cores and reflectors. Because of its importance, the problem has received extensive and varied (but usually piecemeal and semi-intuitive) theoretical attention over the past twenty years. Many experiments have been performed concurrently. The net result has been to perpetuate a lively interest in the problem, since comparisons of experiment with experiment, experiment with theory, and theory with theory have been ragged and controversial. This review presents an adequately precise and general statement of the problem and attempts deductive comparisons of various theoretical attacks upon it. Attention is focused primarily upon the task of obtaining operational descriptions of the diverse approximations explicit or implicit in the calculations considered. Throughout the review attention is persistently directed to an aspect of the problem thst has received less than adequate attention so far, i.e., that of the effect of "flux-hardening" on the absorption rate. An attempt to obtain a qualitative estimate of the importance of this ef-

fect is presented, but the only conclusion drawn so far is that the effect is not obviously an ignorable one. (auth)

26408 TIME-DEPENDENT NEUTRON THERMALIZATION FOR A BARE MULTIPLYING MEDIUM. Edward Garelis (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng., 15: 296-304(Mar. 1963).

A perturbation theory solution is given for the time-dependent, $\exp(-\lambda t)$, neutron thermalization problem for a bare homogeneous multiplying medium. The model is based on diffusion theory with the heavy gas scattering kernel assuming 1/v cross sections with a constant $D/(\xi\sigma_0)$. The fission spectrum is assumed to be a delta function at the mean fission energy, ϵ_f. The fundamental eigenfunction and eigenvalue are expressed in terms of infinite sums involving the Laguerre polynomials at ϵ_f. The sums were evaluated analytically and numerical results are given. (auth)

26409 THERMAL NEUTRON FLUX PERTURBATION DUE TO INDIUM FOILS IN WATER. Jack V. Walker, John D. Randall, and Ronald C. Stinson, Jr. (Agricultural and Mechanical Coll., College Station, Tex.). Nucl. Sci. Eng., 15: 309-13(Mar. 1963).

Flux perturbations due to indium disc foils exposed to an isotropic thermal neutron flux in a water medium were experimentally determined. The unperturbed flux, or the "zero thickness" activity, was determined using foils which matched the moderating ratio of the medium, thereby causing no flux perturbation. Comparison of the results with several modifications of the Ritchie and Eldridge theory gives excellent agreement for foil thickness from 0 to 0.025 in. (auth)

26410 THE NEUTRON FLUX PERTURBATION DUE TO AN ABSORBING FOIL; A COMPARISON OF THEORIES AND EXPERIMENTS. G. C. Hanna (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 15: 325-37(Mar. 1963).

Skyrme has given a theoretical treatment of the perturbation of the neutron flux in a diffusing medium by an absorbing foil. His theory is re-examined, with particular reference to the modification proposed by Ritchie and Eldridge, and the "edge correction" is evaluated. The accuracy of this modified Skyrme theory is tested by comparison with Dalton and Osborn's computer calculations for monokinetic neutrons; the agreement is generally better than 1%. This theory is then extended to a Maxwellian neutron spectrum, for which computer calculations are not available, with the result $(A/A_0) = (\bar{\alpha}/2\bar{\tau}) \cdot (1 + \bar{\epsilon})/(1 + g\bar{\alpha}/2)$. A is the activity per unit mass of a foil of thickness τ (in units of the absorption mean free path), A_0 that of a zero thickness foil, $\alpha = 1 - 2\int_1^\infty x^{-3} \exp(-\tau x)dx$, and $\bar{\tau} \approx t/\pi R$, where t and R are the thickness and radius of the foil. The bars denote averages over the Maxwellian spectrum. The flux-depression parameter g is of the order of R/λ_{tr}, but its exact value depends on the velocity dependence of the transport mean free path, and on the thermalization properties of the medium. This formula is used to obtain, from the available measurements of the dependence of A on foil thickness, "experimental" values of g. For both graphite and hydrogenous media they are smaller than expected. (auth)

26411 NONPERTURBING FOILS—AN EXPERIMENTAL VERIFICATION. J. D. Randall and J. V. Walker (Agricultural and Mechanical Coll., College Station Tex.). Nucl. Sci. Eng., 15: 344-5(Mar. 1963).

Experiments were conducted to confirm the nonperturbing nature of foils whose moderating ratio is equal to that of the medium. The medium studied was water, and the foils were in the form of D_2O solutions of indium nitrate in cylindrical lucite containers. The results showed that foils of thickness varying by a factor of four yield the same specific activity, and that the specific activity of these foils is equal to the unperturbed value determined by an extrapolation method. (D.L.C.)

26412 ON THE ESTIMATION OF FLUX AT A POINT BY MONTE CARLO. M. H. Kalos (Nuclear Development Associates, Inc., White Plains, N. Y.). Nucl. Sci. Eng., 16: 111-17(May 1963).

In estimating flux at a point in a Monte Carlo calculation one estimator uses the uncollided flux at a detector from each sampled collision point. This method is shown to have infinite variance. The average value converges to the expected value but the error decreases asymptotically as the inverse cube root of the number of histories. By using the once collided flux and by proper choice of the intermediate collision point the variance may be made finite. Results of numerical experiments show the finite variance methods to be preferable. (auth)

26413 PROBABILITY DISTRIBUTION OF NEUTRONS AND PRECURSORS IN MULTIPLYING MEDIUM. [PART] II. George I. Bell, W. A. Anderson, and D. Galbraith (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 16: 118-23(May 1963). (LADC-5508)

A numerical program is described for calculating the probability distribution of neutrons or delayed neutron precursors in a multiplying assembly. The program obtains the probability distribution generating function, from which the distribution itself is found by inversion of a Laplace transform. Six groups of delayed neutrons may be used. The prompt neutron lifetime is arbitrary and neutron source and reactivity may be functions of time. The existence of an asymptotic probability distribution at late times is proved for constant reactivity. Six group results are shown to be in good agreement with experimental data from Godiva. (auth)

26414 THE CONVERGENCE OF THE EQUIPOISE METHOD. G. K. Kristiansen (Danish Atomic Energy Commission, Roskilde, Denmark). Nucl. Sci. Eng., 16: 133-4 (May 1963).

Examples of possible convergence and divergence of the Equipoise codes for neutron group diffusion calculations are discussed. It is concluded that convergence criteria should be established before the Equipoise codes can be trusted. (D.L.C.)

26415 A REMARK ON THE MEASUREMENT OF THE DIFFUSION COEFFICIENT FOR THERMAL NEUTRONS. Henry C. Honeck and Paul Michael (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 16: 140-2(May 1963). (BNL-6604)

The correction made by N. P. Baumann (Nucl. Sci. Eng., 14:179) for distortion of the neutron spectrum in his measurements of thermal neutron diffusion coefficients in D_2O, is criticized as being made on an intuitive basis. It is shown how the correction should be made, and the diffusion coefficients are recomputed from Baumann's data. The results are D = 0.823, 0.895, 0.969, and 1.070 cm at 20, 100, 165, and 220°C, respectively. The results of applying the analysis to other data are also given. (D.L.C.)

26416 RE: A REMARK ON THE MEASUREMENT OF THE DIFFUSION COEFFICIENT FOR THERMAL NEUTRONS. N. P. Baumann (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Sci. Eng., 16: 142(May 1963).

Honeck's recomputations of the thermal neutron diffusion

coefficients in D_2O, in the previous paper are discussed briefly. The various corrections involved are discussed. (D.L.C.)

26417 BOUNDARY CONDITIONS FOR THE NEUTRON FLUX IN A FINITE CYLINDER BY THE P_L APPROXIMATION OF THE TRANSPORT EQUATION. D. Emendoerfer (Technische Hochschule, Stuttgart). Nukleonik, 5: 74-82 (Feb. 1963). (In German)

Boundary conditions for the flux moment were derived for a cylindrical reactor reflecting on all sides with a hollow cylinder over the fission zone (spherical pile reactor). Initially, these conditions were determined at the boundaries of two media in (ρ,z) geometry by using a proposal of Rumjancev on the stability of the normal components of the vector flux. Corresponding conditions for the exterior boundary (against the vacuum) are shown to be equivalent to the multi-dimensional problems of the generalized Marshak conditions. Cavities were introduced over the neutron balance for irradiated surfaces in the diffusion problem. Under assumption of the Lambert law for the radiation at the cavity surface, the boundary conditions for the finite hollow cylinder can be given explicitly. (tr-auth)

26418 INELASTIC SCATTERING OF COLD NEUTRONS BY SOLID AND LIQUID LEAD. Maurice Joseph Cotter. Thesis, New York, Fordham Univ., 1962. 98p.

The Brookhaven slow chopper apparatus was used to investigate the inelastic scattering of cold neutrons by Pb. Be-filtered neutrons are scattered at 90° in this facility, and their scattered energies are determined by standard time-of-flight techniques. Above the melting point of Pb, an inelastic peak was observed at a neutron energy gain of approximately 8 mv. A single crystal of Pb was oriented in the beam of cold neutrons so as to minimize single phonon contributions in the energy region in which the inelastic peak in the liquid is found. This orientation was studied with the cold neutron facility as a function of sample temperature. The multiphonon spectrum grows with increasing temperature in the energy range in which the inelastic liquid spectrum is found. The spectrum of the single crystal of Pb, oriented so as to observe the multiphonon spectrum, was extrapolated from 300°C to 335°C by means of an incoherent approximation. These extrapolated data were then subtracted from the inelastic spectrum of the liquid at 335°C. The resultant spectrum is due to damped single phonon processes in the liquid. The same procedure was used to investigate the inelastic scattering in Pb at 400°C. This work gives clear evidence that the liquid Pb atoms dwell in the field of their neighbors for several oscillations before making a diffusive jump. (Dissertation Abstr.)

Nuclear Properties and Reactions

Refer also to abstracts 24762, 24775, and 24891.

26419 (ARF-1193-23) SCINTILLATION SPECTROMETER MEASUREMENTS OF THERMAL NEUTRON CAPTURE GAMMA RAYS FROM NATURAL ELEMENTS. Quarterly Report, February 1, 1963 to April 30, 1963. R. C. Greenwood, J. H. Reed, and R. D. Kolar (Illinois Inst. of Tech., Chicago. Armour Research Foundation). May 21, 1963. Contract AT(11-1)-578. 120p.

A compilation of thermal neutron capture gamma ray spectra of naturally occurring elements, in both the low and the high energy spectral regions, using NaI(Tl) scintillation crystals as detectors is presented. Such a compilation of spectra aids in the evaluation of possible practical applications of neutron capture gamma ray techniques. An external beam from the ARF research reactor is used as a source of thermal neutrons for the measurements. During the period covered, low energy capture gamma ray spectra of silicon, sulfur, chlorine, potassium, iron, strontium, and cesium were obtained using the $1\frac{1}{2}$ in. × 1 in. NaI(Tl) detector and of hydrogen, silicon, chlorine, and osmium with the 3 in. × 3 in. NaI(Tl) crystal. In addition, high energy capture gamma ray spectra of silicon, chlorine, chromium, arsenic, selenium, gadolinium, hafnium, rhenium, osmium, iridium, platinum, and thallium were obtained using the 3 in. × 3 in. NaI(Tl) scintillation detector. (auth)

26420 (CERN-63-13) SEARCH FOR DIRAC MAGNETIC POLES. E. Amaldi, G. Baroni, H. Bradner, H. G. de Carvalho, L. Hoffmann, A. Manfredini, and G. Vanderhaeghe (European Organization for Nuclear Research, Geneva). Apr. 10, 1963. 139p.

Three experiments were performed to ascertain the possible existence of Dirac magnetic poles. The properties of the Dirac poles that appear to be relevant to the planning of the experiments and the interpretation of the corresponding results were presented. The three experiments differ in the properties of the Dirac poles involved in their interpretation. An attempt was made to produce poles in various targets by 28-Bev proton-nucleon collisions or secondary gamma rays. The poles produced in this way lose energy rapidly by ionization and come to rest in the target itself. Targets used included graphite, beryllium, and various diamagnetic and paramagnetic materials. No tracks were observed that could be attributed to a Dirac magnetic pole, but the upper limits for their production were derived. (C.E.S.)

26421 (EUR-10.e) COMPILATION OF CROSS SECTIONS FOR SOME NEUTRON INDUCED THRESHOLD REACTIONS: $Mg^{24}(n,p)Na^{24}$, $Al^{27}(n,\alpha)Na^{24}$, $Al^{27}(n,p)Mg^{27}$, $P^{31}(n,p)Si^{31}$, $S^{32}(n,p)P^{32}$, $Fe^{54}(n,p)Mn^{54}$, $Fe^{56}(n,p)Mn^{56}$, $Ni^{58}(n,p)Co^{58}$. H. Liskien and A. Paulsen (European Atomic Energy Community). Nov. 1961. 41p.

Cross sections for neutron threshold reactions (n,p) with Mg^{24}, Al^{27}, P^{31}, S^{32}, Fe^{54}, Fe^{56}, and Ni^{58} and for the (n,α) reaction with Al^{27} are presented. The cross-section values are printed on several sheets of transparent paper enabling a survey of a given series of measurements separately as well as permitting the intercomparison of different measuring series. Uncertainties of cross section values and neutron energies are indicated. The figures of merit for the reactions are also included. (C.E.S.)

26422 (EUR-122.e) TABLES OF CROSS-SECTIONS OF NUCLEAR REACTIONS WITH NEUTRONS IN THE 14-15 Mev ENERGY RANGE. H. Neuert and H. Pollehn (Hamburg. Universitat). 1963. 173p.

During the last few years many measurements of nuclear reactions with neutrons (n,2n), (n,p), (n,np), (n,d), (n,He^3), (n,t), (n,α), and $(n,n\alpha)$ in the energy range E_n = 14-15 Mev were carried out, so that a compilation of the cross-sections of these reactions seemed to be of general value. Thus, these tables of cross-sections give a general picture of the measured values available, provide a basis for special theoretical considerations, and in some cases point up the urgency of making further investigations on more precise measurements in this field. (auth)

26423 (GA-3125) EXPERIMENTAL TECHNIQUES FOR ACTIVATION MEASUREMENT OF RESONANCE INTEGRALS. M. K. Drake and J. R. Brown (General

Atomic Div. General Dynamics Corp., San Diego, Calif.). Jan. 21, 1963. Contract AT(04-3)-314. 34p.

Techniques and methods developed for the quantitative measurement of the resonance absorption of thorium and other materials in both a reactor spectrum and a 1/E spectrum are presented. The reactor spectrum used is the one that will exist in the Peach Bottom high-temperature gas-cooled reactor. Measurements are also made of the resonance absorption in a spectrum closely approximating 1/E. (C.E.S.)

26424 (IA-827) DECAY OF Br^{83}. M. Pasternak and T. Sonnino (Israel. Atomic Energy Commission, Rehovoth). Mar. 1963. 11p.

Beta and gamma rays from the decay of Br^{83} to the Kr^{83} metastable level were investigated, using scintillation spectrometers. An 0.530 Mev gamma ray following the emission of a beta ray of maximum energy 0.395 ± 0.030 Mev was observed, as well as a beta ray of maximum energy 0.925 ± 0.015 Mev. No evidence of other gamma rays was found. The branching ratios of the two beta groups were determined to be 0.014 and 0.986. The half life of Br^{83} was measured and found to be 2.39 ± 0.03 h. (auth)

26425 (NP-12886) PRODUCTION OF EXCITED K-MESONS ON COMPLEX NUCLEI. E. V. Kuznetsov, Ya. Ya. Shalamov, and A. F. Grashin (Akademiya Nauk S.S.S.R. Institut Teoreticheskoĭ i Eksperimental'noĭ Fiziki). 1963. 8p.

The missing mass spectrum determined by Λ particles from the reaction $\pi^- + N \rightarrow \Lambda + K + n\pi$, where n = 0,1,2, was investigated by exposing freon and xenon bubble chambers to a 2.8 Bev/c π^- beam. In addition to the maximum at 0.88 Bev, corresponding to K^*, relatively narrow peaks were observed at 1.09, 1.2, and 1.26 Bev, while a wider group was observed at about 1 Bev. (D.C.W.)

26426 (NYO-10387) COMPARISON OF REACTIONS OF COPPER-63 COMPOUND NUCLEI FORMED BY ALPHA-PARTICLE, PROTON, AND CARBON-ION BOMBARDMENTS. Carole M. Stearns (Columbia Univ., New York). 1962. Contract AT(30-1)-1019. 84p. (CU-34-63-AEC-1019-CHEM)

A radiochemical investigation of the reactions of alpha particles with Co^{59}, protons with Ni^{62}, and carbon ions with V^{51} was performed to determine the extent to which de-excitation of the Cu^{63} reaction intermediate is independent of its mode of formation. Excitation functions were measured for the $(\alpha,\alpha n)$, $(p,\alpha n)$, $(C^{12},\alpha n)$, $(\alpha,\alpha 2n)$, $(p,\alpha 2n)$, $(C^{12},\alpha 2n)$, $(\alpha,2p)$, $(p,2p)$, $(C^{12},2p)$, $(\alpha,2n)$, and $(p,2n)$ reactions at alpha-particle and proton excitation energies of 20 to 50 Mev and carbon-ion energies up to 120 Mev. Higher probabilities for alpha-particle emission were observed in reactions initiated by alpha particles, and, similarly, incident protons enhanced the proton emission events. It was assumed that all the other measured nuclear reactions were the result of evaporation from a Cu^{63} compound nucleus. The non-compound contributions to the $(\alpha,\alpha n)$, $(\alpha,\alpha 2n)$, and (p,2p) yields were calculated after applying a correction to the Cu^{63} excitation energy to compensate for the different average angular momenta introduced by the protons, alpha particles, and carbon ions. The Co^{57}, Co^{58}, and Co^{61} products were each found to have non-compound components comparable in magnitude and energy dependence to the compound-nucleus portion of the excitation function. 48 references. (auth)

26427 (ORNL-3425) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 31, 1963. (Oak Ridge National Lab., Tenn.). June 7, 1963. Contract W-7405-eng-26. 168p.

Abstracts of 38 papers published or prepared for publication are presented. Individual abstracts are prepared for 32 of 35 papers reporting preliminary results of work in progress. (C.E.S.)

26428 (ORNL-3425(p.1-2)) NUCLEAR STRUCTURE AND THE INELASTIC SCATTERING OF HIGH-ENERGY NUCLEONS. T. Terasawa, R. Haybron, and G. R. Satchler (Oak Ridge National Lab., Tenn.).

The inelastic scattering of high-energy nucleons is used as a probe of nuclear structure for incident energies of ~100 Mev and above, when the nuclear wavelengths become comparable with the distance between nucleons in the nucleus and multiple scattering effects become much less important. Distortion effects in the excitation of the 15.1-Mev level in C^{12} and a comparison of the exact and approximate treatment of the effects of the momentum dependence of the nucleon-nucleon interaction when distorted waves are used are presented. (C.E.S.)

26429 (ORNL-3425(p.5-8)) VALIDITY OF THE DISTORTED-WAVES THEORY OF STRIPPING REACTIONS. G. R. Satchler, R. H. Bassel, and R. M. Drisko (Oak Ridge National Lab., Tenn.).

The validity of the distorted-waves theory of stripping reactions is studied by comparison with experiment, using optical potentials that give good fits to elastic-scattering data. Finite range, spin orbit, and other effects are included. (auth)

26430 (ORNL-3425(p.10)) FLUCTUATIONS AND THE STATISTICAL MODEL OF NUCLEAR REACTIONS. D. M. Brink and G. R. Satchler (Oak Ridge National Lab., Tenn.).

The existence of fluctuations in nuclear cross sections implied by statistical theory of nuclear reactions is investigated. Expressions are given for the mean square deviations of nuclear cross sections when the transition amplitude contains a slowly varying, direct part and a fluctuating, compound nucleus part. (C.E.S.)

26431 (ORNL-3425(p.11-14)) CORRECTION OF ELECTRON LENSES. T. A. Welton and J. Kronsbein (Oak Ridge National Lab., Tenn.).

A discussion is given of the limitations on resolving power of electron and proton microscopes. A novel method, called annular optics, is proposed for obtaining improved resolution. (auth)

26432 (ORNL-3425(p.16-17)) ELASTIC SCATTERING OF ALPHA PARTICLES BY O^{18}. R. D. Powers, J. K. Bair, J. L. C. Ford, Jr., and H. B. Willard (Oak Ridge National Lab., Tenn.).

The α differential elastic scattering cross section for O^{18} was measured for incident energies of 2.4–3.5 Mev and for angles of 90, 125.3, 140.7, and 164.37° in order to determine the level parameters of excited states in Ne^{22}. Previous work on the $O^{18}(\alpha,n)Ne^{21}$ reaction is also presented. Preliminary results give $J = 2^+, 1^-, 1^-, 0^+, 0^+$, and 2^+ corresponding to resonances at 2.47, 2.57, 2.72, 2.90, 3.19, and 3.32 Mev, respectively. (C.E.S.)

26433 (ORNL-3425(p.17-18)) ELASTIC SCATTERING OF ALPHA PARTICLES FROM Si^{28}. J. K. Bair and H. B. Willard (Oak Ridge National Lab., Tenn.).

Yield curves for the elastic scattering of α particles from Si^{28} are presented. Improved resolution was obtained using targets ~3 kev thick for 3-Mev α particles. Data are given for scattering angles of 90, 125, 140, and 162°. (C.E.S.)

26434 (ORNL-3425(p.22-6)) LOW-LYING LEVELS OF Cu^{63} AND Cu^{65}. R. L. Robinson, F. K. McGowan, and P. H. Stelson (Oak Ridge National Lab., Tenn.).

Coulomb excitation in thick targets of Cu^{63} and Cu^{65} was effected with α particles at 4-8 Mev. The gamma yields were determined and compared with the excitation functions predicted. The reduced transition probabilities for excitation were extracted from the gamma yields. Spins of the low-lying excited states of Cu^{63} and Cu^{65} were also presented. (C.E.S.)

26435 (ORNL-3425(p.26-9)) COULOMB EXCITATION OF NUCLEAR STATES IN THE ISOTOPES OF OSMIUM. F. K. McGowan, P. H. Stelson, R. L. Robinson, and J. L. C. Ford (Oak Ridge National Lab., Tenn.).

A summary of the excitation probabilities for the transitions in the decay of states Coulomb-excited in Os^{187} and Os^{189} is presented. (C.E.S.)

26436 (ORNL-3425(p.30-1)) GAMMA-GAMMA ANGULAR CORRELATION IN V^{51}. R. L. Robinson, N. R. Johnson, and G. D. O'Kelley (Oak Ridge National Lab., Tenn.).

In an effort to ascertain the nature of the 933-kev level in V^{51}, the angular correlation of the 613-319-kev gamma cascade that excites it was investigated with 5.8-min Ti^{51}. Comparison was made between theoretical and experimental coefficients for spins of the 933-kev level that are consistent with the E2-M1 character for the 613-kev transition. (C.E.S.)

26437 (ORNL-3425(p.32)) TOTAL NEUTRON CROSS SECTIONS IN ISOTOPES OF Zr, Fe, Cr, AND Ca. H. J. Kim, J. A. Biggerstaff, and W. M. Good (Oak Ridge National Lab., Tenn.).

Total neutron cross section measurements are presented for Zr^{90}, Zr^{91}, Zr^{92}, Zr^{94}, Zr^{96}, Cr^{53}, Ca^{43}, and Fe^{57}. The principal resonances observed are listed. (C.E.S.)

26438 (ORNL-3425(p.32-5)) NEUTRON CROSS-SECTION MEASUREMENTS FROM 1 TO 30,000 ev ON ENRICHED SAMPLES OF THE ZIRCONIUM ISOTOPES. R. C. Block (Oak Ridge National Lab., Tenn.).

Neutron cross section measurements were made on highly enriched Zr^{90}, Zr^{91}, Zr^{92}, Zr^{94}, and Zr^{96} from 1 to 30,000 ev. Over 25 resonances were observed and assigned to individual isotopes. These resonances were analyzed for resonance parameters and these parameters were combined to give information about the s and p-wave strength functions. (C.E.S.)

26439 (ORNL-3425(p.36-45)) LEVEL SPACINGS AND s-WAVE NEUTRON STRENGTH FUNCTIONS OF THE ISOTOPES OF TIN. T. Fuketa, F. A. Khan, and J. A. Harvey (Oak Ridge National Lab., Tenn.).

Neutron transmission measurements were made on highly enriched samples of ten tin isotopes from Sn^{112} to Sn^{124}. The measurements were made from ~30 to 10,000 ev with a resolution of 11 to 18 nsec/m by use of the 180-m flight path and from 0.2 to 100 ev with an energy resolution of 1.5% with the 45-m flight path. Nearly 100 resonances were assigned and values of the s-wave strength function were calculated. (C.E.S.)

26440 (ORNL-3425(p.46-9)) EXCITATION OF COLLECTIVE STATES BY INELASTIC SCATTERING OF 14-Mev NEUTRONS. P. H. Stelson and R. L. Robinson (Oak Ridge National Lab., Tenn.).

The excitation of collective states of Pb, Bi, and S by inelastic scattering of 14-Mev neutrons was undertaken to investigate the prediction that cross sections for excitation of collective states are much larger than given by the statistical theory for compound nucleus interactions in distorted-wave and strong-coupling theories. (C.E.S.)

26441 (ORNL-3425(p.49-55)) DIFFERENTIAL CROSS SECTION OF NEUTRON SCATTERING FROM Pb^{208}. J. L. Fowler (Oak Ridge National Lab., Tenn.).

The neutron differential cross sections of Pb^{208} were measured as a function of incident energies at 0.715 to 1.342 Mev. Spin and parity assignments were made for the resonances encountered. (C.E.S.)

26442 (ORNL-3425(p.57-60)) RESONANT NEUTRON CAPTURE GAMMA-RAY SPECTRA. J. H. Gibbons, W. M. Good, J. R. Bird, and J. A. Biggerstaff (Oak Ridge National Lab., Tenn.).

The gamma spectra from resonant neutron capture were measured for Fe^{54}, Fe^{56}, natural Fe, Pb^{206}, Pb^{207}, and In. New resonances were detected in Pb^{206} and Pb^{207}. (C.E.S.)

26443 (ORNL-3425(p.60-3)) GAMMA-RAY SPECTRA FROM NEUTRON CAPTURE. G. G. Slaughter, J. A. Harvey, G. T. Chapman, and J. R. Bird (Oak Ridge National Lab., Tenn.).

Gamma spectra from the capture of both thermal and resonance energy neutrons in Sn^{118} and Sn^{124} are presented. Thermal neutron capture gamma spectra are presented for natural Cu, Ca^{40}, Ca^{42}, Ca^{43}, Ca^{44}, Ti^{46}, Ti^{47}, Ti^{48}, Ti^{49} and Ti^{50}. Resonance neutron capture gamma spectra are also presented for Cu^{63} and Cu^{65}. (C.E.S.)

26444 (ORNL-3425(p.64-71)) ORNL-RPI CAPTURE EXPERIMENT. R. C. Block, J. E. Russell, and R. W. Hockenberry (Oak Ridge National Lab., Tenn.).

Neutron radiative capture measurements were made on samples of W^{183}, W^{184}, W^{185}, pure Fe, Fe^{56}, Hf^{177}, Hf^{178}, Hf^{179}, and Hf^{180}. Many new resonances were observed in capture, and the data were analyzed for resonance parameters and level spacings. (C.E.S.)

26445 (ORNL-3425(p.72-5)) CHANNEL ANALYSIS OF FAST-NEUTRON-INDUCED FISSION NEAR THRESHOLD. R. W. Lamphere (Oak Ridge National Lab., Tenn.).

Evidence is presented that favors the existence of a K-band sequence of $1/2^+$, $3/2^-$, $1/2^-$ in the heavy nuclei Th^{231}, Th^{233}, and U^{235} near the saddle-point deformation. Several foils of Np^{237} were prepared as standards for cross-section work. (auth)

26446 (ORNL-3425(p.76-9)) MASS DISTRIBUTION AND KINETICS OF U^{235} THERMAL-NEUTRON-INDUCED BINARY AND TERNARY FISSION. H. W. Schmitt, J. H. Neiler, F. J. Walter, A. Chetham-Strode, and M. J. Mader (Oak Ridge National Lab., Tenn.).

The mass distributions and kinetics of U^{235} thermal-neutron-induced binary and ternary fission are obtained from multiparameter fragment energy correlation experiments. Strong influence of the closed-shell nuclei is indicated. (auth)

26447 (ORNL-3425(p.79-82)) FRAGMENT MASS DISTRIBUTION FOR THERMAL- AND RESONANCE-NEUTRON-INDUCED FISSION OF Pu^{239}. F. J. Walter, J. H. Neiler, H. W. Schmitt, and C. W. Williams (Oak Ridge National Lab., Tenn.).

The fragment mass distributions for thermal and resonance-neutron-induced fission of Pu^{239} were determined from correlated energy measurements of fragment pairs. (auth)

26448 (ORNL-3425(p.82-9)) RESONANCE-NEUTRON-INDUCED FISSION OF ORIENTED U^{235} NUCLEI. J. W. T. Dabbs, F. J. Walter, and G. W. Parker (Oak Ridge National Lab., Tenn.).

Measurements were made on the anisotropy of fission fragments from U^{235} with neutron energies in the resonance range. The U^{236} has a positive nuclear electric quadrupole moment aligned with the major nuclear axis in the plane perpendicular to the c-axis of the $UO_2Rb(NO_3)_3$ crystal. (C.E.S.)

26449 (ORNL-3425(p.89-92)) INTERNAL BREMSSTRAHLUNG IN THE BETA DECAY OF He^6. J. K. Bienlein and Frances Pleasonton (Oak Ridge National Lab., Tenn.).

Measurements were made to determine the yield of internal bremsstrahlung (IB) relative to beta emission and also the shape of the internal bremsstrahlung spectrum in the beta decay of He^6. Preliminary analysis of the data gives a value of 0.024 ± 0.006 for the IB yield and a spectral shape that is in good agreement with theory. (auth)

26450 (ORNL-3425(p.92-3)) ANALYSIS OF THE RECOIL ENERGY SPECTRUM FROM THE BETA DECAY OF He^6. C. H. Johnson, Frances Pleasonton, and T. A. Carlson (Oak Ridge National Lab., Tenn.).

The energy spectrum of ions that recoil from the beta decay of He^6 was investigated. The spectra are continuous from 0–1418 ev with a shape depending on the electron-neutrino angular correlation. In terms of a limit for the tensor interaction in beta decay, an electron-neutrino angular coefficient of −0.3343 ± 0.0029 was obtained. (C.E.S.)

26451 (ORNL-3425(p.96-8)) FRAGMENT IONS RESULTING FROM β^- DECAY OF CH_3Br^{82} AND β^+ DECAY OF CH_3F^{18}. T. A. Carlson and R. M. White (Oak Ridge National Lab., Tenn.).

The relative abundances of fragment ions from the β decay of CH_3Br^{82} and the β^+ decay of CH_3F^{18} are presented. The data are discussed in terms of the excitation that arises from the sudden nonadiabatic change in nuclear charge. (C.E.S.)

26452 (ORNL-3425(p.99-102)) MEASUREMENTS OF THE HYPERFINE SPLITTING IN Fe–Rh AND Fe_2O_3 USING THE MÖSSBAUER EFFECT. F. E. Obenshain, L. D. Roberts, H. H. F. Wegener, J. O. Thomson, and D. W. Forester (Oak Ridge National Lab., Tenn.).

Under certain conditions Fe–Rh may be either ferromagnetic or antiferromagnetic, and Fe_2O_3 is antiferromagnetic below T_N = 975°K. The temperature dependence of the internal magnetic fields were measured for both of these materials by use of the Mössbauer effect. (auth)

26453 (ORNL-3425(p.103-11)) CORRELATION OF THE MÖSSBAUER ISOMER SHIFT WITH THE RESIDUAL ELECTRICAL RESISTANCE FOR GOLD ALLOYS. L. D. Roberts, R. L. Becker, F. E. Obenshain, and J. O. Thomson (Oak Ridge National Lab., Tenn.).

Measurements were made of the Mössbauer isomer shift of Au for Ni–Au, Ag–Au, Cu–Au, Pd–Au, and Cu–Ni–Au alloys. The results were compared with a simple theory that gives information about the filling of the S-band in the alloy. (C.E.S.)

26454 (ORNL-3425(p.112-17)) TOTAL REFLECTION OF RECOIL-FREE NUCLEAR RESONANCE RADIATION FROM Fe^{57}. E. C. Campbell and S. Bernstein (Oak Ridge National Lab., Tenn.).

The coherent resonant recoil-free scattering of gamma rays was studied by total reflection techniques. Measurements were made of the intensity of the 14.4-kev gamma rays reflected at a small glancing angle from an Fe^{57} mirror as a function of the glancing angle and the source velocity. The results clearly exhibit effects due to interference between the contributions of electronic and nuclear scattering as well as the mutual interference of the individual resonances in Fe^{57}. (C.E.S.)

26455 (ORNL-3425(p.118-19)) MAGNETIC STUDY OF DYSPROSIUM–YTTRIUM ALLOYS. H. R. Child, W. C. Koehler, E. O. Wollan, and J. W. Cable (Oak Ridge National Lab., Tenn.).

Magnetic measurements made on dysprosium-yttrium alloys indicate that the dilution of dysprosium with yttrium stabilizes the antiferromagnetic state at the expense of the ferromagnetic state. Magnetic transition temperatures were obtained from intensity vs temperature curves of the most intense magnetic reflection in the alloy. The ferromagnetic transition is completely suppressed in the absence of an applied magnetic field when as little as 10% yttrium is introduced. (C.E.S.)

26456 (ORNL-3425(p.120-3)) MAGNETIC PROPERTIES OF THE Pd_3Mn–Pt_3Mn SYSTEM. J. W. Cable, E. O. Wollan, W. C. Koehler, and H. R. Child (Oak Ridge National Lab., Tenn.).

Neutron diffraction and magnetization measurements were made on ordered alloys of composition $Pd_3Mn \cdot Pt_3Mn$ and $3Pd_3Mn \cdot Pt_3Mn$. $Pd_3Mn \cdot Pt_3Mn$ was found to be ferromagnetic below 210°K with an average moment of 1.02 μ_B/atom. For $3Pd_3Mn \cdot Pt_3Mn$, the data indicate ferromagnetic clusters of about 17 A diam that couple antiparallel at low temperatures. (auth)

26457 (ORNL-3425(p.124-7)) MAGNETIC STRUCTURE OF RARE-EARTH IRIDIUM COMPOUNDS RIr_2. Gian Felcher and W. C. Koehler (Oak Ridge National Lab., Tenn.).

Neutron diffraction measurements on $TbIr_2$ and $HoIr_2$ confirm the low molecular moments deduced from magnetic measurements. Partial quenching of the orbital angular momentum of the rare-earth atoms is indicated. The coherent scattering amplitude of iridium was determined to be $(1.00 \pm 0.02) \times 10^{-12}$ cm. (auth)

26458 (ORNL-3425(p.128-30)) OPTICAL PHYSICS. G. W. Charles, P. M. Griffin, et al. (Oak Ridge National Lab., Tenn.).

A detailed study was made of an electrically excited krypton-mercury mixture as a possible amplifying medium for an optical maser. Although optical pumping remains a possibly feasible approach, collisional pumping was ruled out. (auth)

26459 (ORNL-3425(p.130-3)) RESPONSE OF SILICON SOLID-STATE DETECTORS TO HEAVY IONS AND FISSION FRAGMENTS. H. W. Schmitt, F. J. Walter, et al. (Oak Ridge National Lab., Tenn.).

The pulse height vs energy relation was measured for high-energy bromine and iodine ions incident on silicon solid-state detectors. Energies up to 120 Mev were obtained. The experiment was performed in an effort to eliminate the uncertainties in fragment energy calibrations with respect to time-of-flight measurements. (C.E.S.)

26460 (PAN-231) GAMMA–GAMMA DIRECTIONAL CORRELATIONS IN ^{146}Eu. E. Božek, H. Niewodniczański, S. Ogaza, M. Rybicka, and J. Styczeń (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). Jan. 1963. 7p.

Gamma-gamma directional correlations for the triple cascade in Eu^{146} were measured. An alternative assignment for the decay scheme was established. (auth)

26461 (PAN-241) ZAGADNIENIA ELASTYCZNEGO ROZPRASZANIA DEUTERONÓW NA JADRACH ATOMOWYCH. (Problems of the Elastic Scattering of Deuterons on Atomic Nuclei. A. Strzalkowski (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). Jan. 1963. 48p.

The results of measurements of angular distributions and polarization in elastic scatterings of deuterons on atomic nuclei are discussed. The formalism for the description of scattering of the spin one particles is given. 48 references. (auth)

26462 (PAN-367/VI) ANGULAR DISTRIBUTION OF RELATIVISTIC PARTICLES FROM 16 Gev NEGATIVE PION INTERACTIONS WITH HEAVY NUCLEI IN EMULSION. Pelagia Ciok, Teresa Saniewska, and Przemysław Zieliński (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Oct. 1962. 11p.

The angular distribution of lightly ionizing particles from 92 interactions of 16 Bev negative pions with heavy nuclei of emulsion ($N_h > 8$) was investigated. (auth)

26463 (PAN-374/VI) QUASI-ELASTIC SCATTERING OF 7-Gev/c PIONS AND THE PROTON MOMENTUM DISTRIBUTION IN CARBON NUCLEI. Leon Michejda (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1962. 18p.

Quasi-elastic scattering of 7-Bev/c negative pions on protons bound in carbon nuclei was studied in a propane bubble chamber. On the basis of 188 events the total quasi-elastic cross section was estimated to be 6.21 ± 0.91 mb. From measurements of the directions of the secondary pions and protons it was possible to determine the nucleon momentum distribution in carbon. In the region up to 300 Mev/c, it was found that a gaussian distribution falling to 1/e at a momentum corresponding to a kinetic energy of 10.26 ± 2.60 Mev gives good agreement with the experimental data. (auth)

26464 (PAN-397/VI) FREQUENCY OF THE EMISSION OF ^{8}Li FRAGMENTS FROM INTERACTIONS OF 24-Gev PROTONS WITH HEAVY EMULSION NUCLEI. [PART] II. Wojciech Gajewski, Tadeusz Pniewski, Jolanta Siemińska, Marta Sołtan, Krzysztof Sołtyński, Joanna Suchorzewska, and Krzysztof Falkowski (Warsaw. Univ. Inst. of Experimental Physics and Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Feb. 1963. 15p.

About 200 hammer tracks from the 24-Bev proton interactions with heavy emulsion nuclei were collected. After a careful analysis of possible biases the total emission frequency of Li^8 fragments for $N_h < 8$ stars was found to be (2.49 ± 0.24)%. The emission frequency for different N_h intervals was investigated. An additional sample of $N_h \geq 27$ interactions of 9-Bev protons was also collected and the emission frequency of Li^8 fragments for these stars was found. (auth)

26465 (PAN-400/I) THE EFFECTIVE CROSS SECTIONS OF (n,p) REACTIONS PRODUCING ISOMERIC AND GROUND STATES OF INDIUM AND ANTIMONY ISOTOPES. J. Brzosko, P. Decowski, and Z. Wilhelmi (Warsaw. Univ. and Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Feb. 1963. 19p.

14.2 Mev neutron-activation cross sections were measured for (n,p) reactions producing the isomeric as well as the ground states of several indium and antimony isotopes. As the target material the separated tin and tellurium isotopes were used. The analysis of the reaction products was performed by measurements of their disintegration periods and by successive measurements of the gamma spectrum of the observed reaction products. In some cases the chemical separation was used. The experimental results are compared with values calculated from the statistical theory of nuclear reactions accounting for the nucleon pairing energy. The existence of Levkowskij's isotopic effect in the A-dependence of the (n,p) reaction was confirmed. (auth)

26466 (PAN-407/IX) THERMAL NEUTRON ACTIVATION CROSS-SECTIONS OF SOME NUCLIDES USED IN ACTIVATION MEASUREMENTS. Edward T. Józefowicz (Polish Academy of Sciences. Inst. of Nuclear Research Warsaw). Mar. 1963. 9p.

The method of absolute beta activity measurements in liquid scintillators was used to measure the thermal neutron activation cross-sections of phosphorus, iodine, and indium in relation to sodium and manganese. The following results were obtained: $\sigma_{oP} = 0.172 \pm 0.008$ b; $\sigma_{oJ} = 5.8 \pm 0.2$ b; $\sigma_{oIn} = 154 \pm 6$ b; and $\sigma_{oMn}/\sigma_{oNa} = 25.0 \pm 0.2$. (auth)

26467 (TID-18776) 2.95-Mev AND 14.8-Mev NEUTRON-INDUCED FISSION OF Th^{232}. K. M. Broom (Arkansas. Univ., Fayetteville). [1963]. Contract [AT (40-1)-1313]. 46p.

Fission yields were determined radiochemically for sixteen mass chains of $89 \leq A \leq 140$ from neutron-induced fission of Th^{232} using 14.8-Mev neutrons and for ten mass chains of $91 \leq A \leq 139$ using 2.95-Mev neutrons. The values determined were presented. Fine structure in the mass yield curves in the region A = 131-135 was observed at both neutron energies with the peak in the fine structure occurring at A = 134. (auth)

26468 (UCRL-10695) ESTIMATES OF FISSION-FRAGMENT KINETIC-ENERGY DISTRIBUTIONS ON THE BASIS OF THE LIQUID-DROP MODEL. James Rayford Nix (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1, 1963. Contract W-7405-eng-48. 30p.

A model is discussed in which a fissioning nucleus is represented by an idealized charged liquid drop whose shape is constrained to the family of shapes generated by two overlapping or separated spheroids. On the basis of this model, the distribution of total translational kinetic energy of fission fragments is calculated. The dynamics of the separation of two completely symmetrical drops was studied using an IBM 7090 computer to integrate the classical equations of motion. For this restricted case it was found that the final translational kinetic energy is approximately related in a very simple way to the initial conditions at the saddle point. The distribution of initial conditions at the saddle is determined by transforming to normal coordinates and assuming statistical equilibrium. This results in a Gaussian probability distribution for each coordinate and conjugate momentum, with a temperature-dependent width. From this and the above-mentioned relationship between kinetic energy and initial conditions, the distribution of final kinetic energy is determined. For a range of nuclei, the experimentally observed most probable kinetic energy is compared with that predicted by the model. Also, the predicted variation of the width of the kinetic-energy distribution with nuclear temperature is compared with preliminary experimental data. (auth)

26469 (UCRL-10765) HEAVY ION COULOMB EXCITATION OF DEFORMED NUCLEI. F. S. Stephens, B. Elbek, and R. M. Diamond (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1963. Contract W-7405-eng-48. 29p.

The Coulomb excitation of Tb^{159}, Ho^{165}, Tm^{169}, Th^{232}, and

U^{238} was studied using O^{16} ion projectiles at 60-80 Mev to determine detailed level schemes. The gamma spectrum, conversion electron spectrum, and level scheme of Tb^{159}, Ho^{165}, and Tm^{169} and energy analysis of the ground-state rotational-band members for Ho^{165} and Tb^{159} are presented. The electron spectrum and level scheme of Th^{232} and U^{238} are also presented. (C.E.S.)

26470 (UCRL-10767) EFFECT OF ANGULAR MOMENTUM ON NEUTRON EMISSION FROM Tb AND Dy COMPOUND NUCLEI. Gabriel N. Simonoff and John M. Alexander (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1963. Contract W-7405-eng-48. 19p.

The effects of angular momentum and excitation energy on neutron emission were studied in the production of Tb^{149g}, Dy^{150}, and Dy^{151} by heavy ion reactions. The heavy ions employed were B^{10}, B^{11}, C^{12}, N^{14}, O^{16}, F^{19}, and Ne^{20}. The number of neutrons emitted in the reactions ran from 3 to 9. The angular and range distributions and excitation functions were determined. The target materials were Pr^{141}, Nd^{146}, Nd^{142}, Nd^{144}, Ba^{136}, and Ce^{140}. (C.E.S.)

26471 (UCRL-10780) ATOMIC BEAM MEASUREMENTS OF THE NUCLEAR SPINS OF COPPER-62 AND IRON-59 AND THE HYPERFINE-STRUCTURE SEPARATION OF COPPER-61 AND COPPER-62 (thesis). Barbara Marie Dodsworth (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 18, 1963. Contract W-7405-eng-48. 123p.

The atomic beam magnetic resonance method of the flop-in type using the technique of radioactive detection was employed to measure the nuclear spins of Cu^{62} and Fe^{59} as well as the hyperfine-structure separation ($\Delta\nu$) of Cu^{61}, the sign of the moment of Cu^{61}, and an improved value for the $\Delta\nu$ of Cu^{64}. The magnetic moment of Cu^{61} was calculated from the Fermi-Segrè formula, using previously measured values for the $\Delta\nu$ and μ_I of Cu^{63}. The results of the experimental work, together with calculated values of the nuclear magnetic dipole moments, are presented. The Cu^{61} isotope was produced on the Berkeley 60-inch cyclotron by the reaction $Co^{59}(\alpha,2n)Cu^{61}$. The Cu^{62} isotope was also produced on the cyclotron by the decay of Zn^{62} formed by the reaction $Ni(\alpha,2n)Zn^{62}$. Both the Cu isotopes were chemically separated from the target materials. The Cu^{64} was formed by neutron bombardment of copper in the Livermore and Vallecitos reactors; Fe^{59} was produced by irradiation with neutrons in the ETR reactor in Idaho. Radioactivity in the beam was measured by exposing collectors to the beam and counting these buttons in either sodium iodide crystal scintillation counters or continuous-flow methane counters, depending on the mode of decay of the particular isotope. Theory of atomic structure, a description of the experimental apparatus and techniques employed, methods of data analysis, and results are presented. The results are interpreted in terms of simple nuclear shell-model theory. (auth)

26472 POLARIZATION OF 6.3-Mev PROTONS ELASTICALLY SCATTERED BY C^{12}. N. Martalogu, E. Iliescu, and M. Cenja (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 927-31 (1962). (In Rumanian)

The polarization of 6.3-Mev protons elastically scattered by C^{12} was determined, and the value $P = -0.46 \pm 0.06$ was obtained for an angle of 60°. Experimental values given by Evans (Nuclear Phys., 27: 41(1961)) were used to calibrate the installation. (tr-auth)

26473 YIELD OF PROMPT GAMMA RADIATION FROM FISSION OF U^{235} BY THERMAL NEUTRONS. Fritz Ernst Walter Rau (Technische Hochschule, Munich). Ann. Physik (7), 10: 252-80(1963). (In German)

A double ionization chamber was used to measure the kinetic energy of the fragments appearing in the fission of U^{235}. A scintillation counter served to detect the gamma quanta and measure their energy. The counter pulses were processed electronically so that in case of a coincidence in the mass ratio, the fragments as well as the gamma energy proportional impulses could be stored photographically in a two-dimensional multichannel process. The observed coincidence spectra were corrected for the influence of the prompt fission neutrons. The absolute gamma yield amounted to 7.93 ± 0.48 quanta/fission. The dependence of the absolute gamma yield on mass ratio of the fragments was plain at $M_1/M_2 = 1.2$ and harder to recognize at $M_1/M_2 = 1.9$. The dependence of the reduced energy spectra on the mass ratio of the fragments at $E_\gamma = 160$ kev showed a preference for symmetrical fission. (tr-auth)

26474 INVESTIGATION OF THE DECAY OF Rh^{104}. K. Wien (Technische Hochschule, Munich). Ann. Physik (7), 10: 281-94(1963). (In German)

Measurements were made to detect and characterize the 97-kev level in the gamma decay of Rh^{104}. The 31-kev transition leading to the 97-kev level represented a phase of the isomer. Both states of the Rh^{104} nucleus are probably different only in spin orientation of the unpaired nucleon groups. In order to completely understand the decay scheme of the 4.4-min isomer of Rh^{104}, the conversion coefficients of the 51-kev and the isomeric 77-kev transitions were measured. (M.C.G.)

26475 ON THE THEORY OF γ-γ ANGULAR CORRELATIONS FOR COMBINED MAGNETIC AND INHOMOGENEOUS ELECTRIC FIELDS. III. NUMERICAL RESULTS. Harry Paul and Witlof Brunner (Deutschen Akademie der Wissenschaften, Berlin). Ann. Physik (7), 10: 327-31(1963). (In German)

For the case of a source in the form of powder and a spin $^5/_2$ of the intermediate states of the γ-γ cascade, numerical results for the real part of the diminishing coefficient and their dependence on the amount of the electric and magnetic reciprocal-effect energy were determined. The indium experiment was considered for the direction of the magnetic field perpendicular to the plane of the counter. (tr-auth)

26476 INELASTIC NEUTRON SCATTERING SPECTRA AND CROSS SECTIONS OF U, Th, Hg, W, Sb, Cd, Mo, Nb, AND Fe NUCLEI IN THE 0.2 TO 1.2-Mev RANGE. N. P. Glazkov. At. Energ. (USSR), 14: 400-2(Apr. 1963). (In Russian)

A small spherical chamber filled with He^3 to a pressure of 40 atm was used for measuring the inelastic neutron cross section spectra in the 0.4 to 1.2-Mev range. An inverse spherical geometry was used for studying the inelastic scattering phenomena. The scattering targets consisted of 30-mm thick spherical layers of the natural isotopic mixture of the materials studied; they were prepared in most cases by pouring the powders into suitable stainless steel containers. A tritium target exposed to a proton beam was used as the neutron source. A 0.2-mm thick Cd cover protected the chamber from thermal neutrons. The spectrum was recorded by a 128-channel pulse-amplitude analyzer. In order to determine the inelastic scattering effect, the spectra were determined with and without the scatterer. Total inelastic cross section values were obtained with an accuracy of 10%; partial cross section values with an accuracy of 10 to 15%. The values obtained are presented in a tabular form, including also the

inelastic scattering cross section of Fe as a control. These latter values, – 0.28 ± 0.04 barn for the 1-Mev neutrons and 0.55 ± 0.05 barn for the 1.2-Mev neutrons, agree satisfactorily with previously reported data. (TTT)

26477 NUCLEAR ENERGY. WHAT IT IS AND HOW IT ACTS. Andrew W. Kramer. Atomics, 16: No. 3, 37-41 (May-June 1963).

A treatment is presented of nuclear interactions. The cloudy crystal ball model of the nucleus is discussed. The meaning of cross section and its measurement are discussed in detail. (D.L.C.)

26478 NOTE ON THE COMPETITION BETWEEN γ AND PROTON EMISSION IN THE DE-EXCITATION OF THE COMPOUND NUCLEUS. Jean Delorme (Institut de Physique Nucléaire, Lyon). Compt. Rend., 256: 3452-5 (Apr. 17, 1963). (In French)

The presence of low-energy protons in experimental spectra was attributed to secondary reactions. The explanation utilized the statistical model. An application to the case of the (α,np) reaction on Cu^{63} was in good agreement with experimental results. (tr-auth)

26479 MÖSSBAUER EFFECT IN W^{182} STUDIED BY THE γ-γ COINCIDENCE METHOD. G. Bonchev, L. Mitrani, S. Ormandjiev, B. Skorchev, and I. Ouzounov. Compt. Rend. Acad. Bulgare Sci., 16: 15-16(1963).

The directly recorded Mössbauer effect for W^{182} can be considerably increased by the use of the γ-γ-coincidence method. The strong Compton background of gamma transitions with energies close to that of the resonance one was eliminated with the coincidences. The intensity of the scattered radiation produced by the W target with a change in the temperature of the source from –196.8 to 20°C was measured. The difference in intensity proved to be 9.5 ± 3.5%. (OTS)

26480 SPIN OF THE 160-kev LEVEL IN TITANIUM-47. M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Current Sci. (India), 31: 372(Sept. 1962).

To investigate the spin of the 160-kev level, studies on the decay of 31-min V^{47} were carried out. V^{47} was produced by a (p,n) reaction on stable Ti. The single γ-ray spectrum observed in a 1 × 2 in. NaI counter revealed the presence of only annihilation radiation. The γ-ray spectrum in coincidence with positrons (annihilation radiation) was studied up to 600 kev. Neither the 160-kev photon nor any other emission was observed in this energy range. An upper limit of 0.5% could be set on the number of 160-kev photons per positron yielding a log ft lower limit of 7.2. The absence of V^{47} decay to the 160-kev level in spite of the large energy available and the presumably favorable spin situation was not readily explainable. However, it was possible to assign a spin of $^7/_2^-$ to the V^{47} ground state and $^3/_2^-$ to the 160-kev level in Ti^{47}. This would make the decay to the latter level second forbidden and would account for the nonobservance of branching. Sc^{47} may be assigned a spin of $^5/_2^-$. (TCO)

26481 SEARCH FOR A 0^+ EXCITED STATE IN Sr^{88}. M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Current Sci. (India), 31: 416(Oct. 1962).

An experiment was carried out to locate a 0^+ state in Sr^{88}. Search for the 0^+ level was based on the argument that: if the 0^+ level exists close to but above the 1.84-Mev level, that state would not be populated either by direct decay of Y^{88} or by decay of the 3^- level in Sr^{88} at 2.76 Mev. On the other hand, if the 0^+ state lay below the 1.84-Mev (2^+) level, then, depending upon how far below this state was located, it might be reasonable to expect a weak branching to the 0^+ level by depopulation of the 1.84-Mev level through which all the transitions reach the ground state of Sr^{88}. However, the E2 decay of the 1.84-Mev level to the hypothesized 0^+ level has to compete with the E2 decay to the ground state of Sr^{88}. The method employed consisted in determining γ-γ coincidences between the 0.9-Mev γ ray that results from the decay of the 2.76-Mev level to the 1.84-Mev level, and any other γ ray that would connect the 1.84-Mev level and the 0^+ level. The results were negative. (TCO)

26482 PROBLEMS OF NUCLEAR REACTIONS. V. F. Weisskopf (CERN, Geneva). Energia Nucl. (Milan), 9: 644-56(Nov. 1962). (In Italian)

A summary is given of the present situation of nuclear physics, specially as far as nuclear structure is concerned. The various nuclear models are qualitatively discussed both from the point of view of nuclear spectroscopy and of the mechanism of nuclear reactions. (auth)

26483 MULTIPLE COULOMB EXCITATIONS OF DEFORMED NUCLEI. Derek W. Robinson (Eidgenössische Technische Hochschule, Zurich). Helv. Phys. Acta, 36: 140-54(1963). (In English)

A formalism was developed for the purpose of investigating the multiple Coulomb excitation of deformed nuclei. The formalism yields an expression for the time-development matrix describing the nuclear states that has a form similar to the solution given by the "sudden approximation." It is shown that this formalism may be applied to the problem of the excitation of rotational nuclei, and an expression was obtained for corrections to the sudden approximation. This expression contains corrections of all orders in ξ and has the advantage that it is free of divergences. The corrections may be most readily calculated in the equal-spacing approximation, an approximation in which the energy levels of the bombarded nucleus are assumed to be equally spaced. The formalism can also be applied to the excitation of vibrational nuclei, taking both one-phonon and two-phonon processes into account. It is shown that the time-development matrix may be expressed in closed form, and earlier results concerning the effects of the two-phonon processes are extended. (auth)

26484 PHASE SHIFT ANALYSIS IN SINGLE-CHANNEL REACTIONS. G. Pisent (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Helv. Phys. Acta, 36: 248-56(1963). (In English)

A general method for phase-shift analysis of single-channel reactions is outlined for the general case of arbitrary maximum orbital angular momentum and discussed in detail for S, P, and D wave analyses. The phase-shift ambiguities are related to the mathematical structure of the cross section. (M.C.G.)

26485 PHOTO-ACTIVATION OF CADMIUM-111m AND INDIUM-115m BY COBALT-60 IRRADIATION. A. Veres (National Atomic Energy Commission, Inst. of Isotopes, Budapest). Intern. J. Appl. Radiation Isotopes, 14: 123-8(Mar. 1963). (In English)

A (γ,γ')A*-type photo-activation experiments on In^{115} and Cd^{111} were carried out using the γ rays from a 424-C activity Co^{60} source. Excitation of the nuclear isomers In^{115m} and Cd^{111m} by nuclear γ radiation not yet reported in the literature could be achieved. The widths of the activation levels are estimated from the experimental results and some possible practical uses of the method are suggested. (auth)

26486 PRODUCTION OF CARRIER-FREE RADIO-FLUORINE-18 AND DETERMINATION OF ITS HALF-

LIFE. K. Beg and F. Brown (Atomic Energy of Canada Ltd., Chalk River, Ont.). Intern. J. Appl. Radiation Isotopes, 14: 137-41(Mar. 1963). (In English)

A simple and effective procedure for the preparation of carrier-free F^{18} is described. The F^{18} is produced by neutron irradiation of Li_2O and is separated by passing the dissolved oxide through a cation exchange column. The yield is 95%, radioactive impurities <1 ppm, and the lithium content of the solution <0.2 ppm. The half life of F^{18} was measured as 109.6 ± 0.6 min. (auth)

26487 THE ENERGIES OF THE FIRST 2^+ LEVELS, AND THE REDUCED PROBABILITIES OF E2-TRANSITIONS TO THESE LEVELS IN SPHERICAL NUCLEI. B. L. Birbrair, K. I. Erokhina, and I. Kh. Lembert. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 150-71(Feb. 1963). (In Russian)

The energies of the first excited, 2^+, collective levels and the values of the reduced probability B(E2) of the electric quadrupole transition during the $0 \rightarrow 2^+$ excitation of these 2^+ levels were calculated over a wide range of atomic numbers, and were compared with the experimental values. It was assumed that the nucleons in a central self-consistent field of the nucleus interact with each other by pairing forces, and by quadrupole-quadrupole residual forces. All the elements were divided into six groups depending on the neutron and proton shells of the elements. Nielsson's scheme for the single-particle energy levels of the six groups was adopted with some modifications. Initial values of the pairing constant G_γ were taken from Kisslinger, and solutions were sought for each of the variants for eleven values of the constant G_γ. It was necessary to solve 4686 pairs of nonlinear equations on a computer. The optimum value of the pairing constant was selected by comparing the theoretical and experimental values of the even-odd differences in mass. The transition probabilities $B(E2)_{0\rightarrow 2^+}$ were calculated by using single-particle states which gave the least divergence in the values of the 2^+ energy levels for the isotopes of a given element. In general, the agreement between the calculated and experimental values of the transition probabilities $B(E2)_{0\rightarrow 2^+}$ and of the energies of the 2^+ level was within a factor of two for 60 spherical nuclei with atomic numbers varying from 20 to 82. (TTT)

26488 THE CONVERSION ELECTRON SPECTRA OF Tc^{95m} AND Tc^{96}. B. S. Dzhelepov, G. S. Katykhin, V. K. Maidanyuk, and A. I. Feoktistov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 172-6(Feb. 1963). (In Russian)

Tc^{95}($T_{1/2}$ = 60 d.) and Tc^{96}($T_{1/2}$ = 4.3 d.) were separated radiochemically from a molybdenum foil irradiated with 13.6-Mev deuterons. The conversion electron spectrum of Tc^{95} was determined, and compared with the data of Unik and Rasmussen in Phys. Rev., 115: 1687(1959). The relative intensities and possible multipolarities are given for the following transitions of Tc^{95}: the 204.2, 256, 583.9, 617, 767.9, 788, 822.5, 837.3, and 1042 kev transitions. A decay scheme for Tc^{95} is presented. With the use of an $\alpha_K = 1.25 \times 10^{-3}$ for 779 kev transition of Tc^{96}, the internal conversion coefficients were determined for the 318, 812.2, 852.5, and 1128 kev transitions in Tc^{96}. The internal conversion coefficients, and possible multipolarities of the γ transitions in Tc^{96} are tabulated. A decay scheme for Tc^{96} could not be presented, because the conversion electron spectrum above 1128 kev was not determined. (TTT)

26489 THE DECAY OF Tm^{163}. K. Ya. Gromov, B. S. Dzhelepov, V. Zvol'ska, I. Zvol'skii, and V. G. Kalinnikov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 182-94(Feb. 1963). (In Russian)

A thulium fraction was separated from a tantalum target irradiated with 660-Mev protons, and the conversion electron spectrum of Tm^{163} was determined on a double focusing β spectrometer. The half life of Tm^{163} was found to be 109 minutes. A comparison of theoretical with experimental values of the conversion coefficients at the K- and L-shells shows that the 104.4-kev transition is of the M1 type. A decay scheme for Tm^{163} is presented, and compared with that given by Harmatz in Phys. Rev., 114: 1082(1959). The quantum characteristics of the ground state of Er^{163} are taken as $5/2^-$ [523] on the basis of decay systematics. The 83.9-kev transition (type E2) represents the first rotational level of Er^{163}. The intense 104.4-kev transition in the decay of Tm^{163} is a single-particle level with quantum characteristics of $3/2^-$ [521]. The levels at 164.4 and 249.7 kev belong to a rotational band based on the 104.4-kev state. The quantum characteristics of other levels in Er^{163} are discussed. (TTT)

26490 THE DECAY SCHEME OF Tm^{165}. K. Ya. Gromov, B. S. Dzhelepov, V. Zvol'ska, I. Zvol'skii, A. V. Zolotavin, L. L. Pelekis, and Z. E. Pelekis. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 195-9(Feb. 1963). (In Russian)

Tm^{165} was obtained from the spallation of Ta by 660-Mev protons. The conversion electron spectrum was determined on a $\pi\sqrt{2}$, double-focusing β spectrometer, and the multipolarities of most transitions having energies of <400 kev were obtained by comparing the theoretical and experimental values of the ratios of intensities of $K : L_1 : L_2 : L_3$. The internal conversion electron coefficients for a number of the more intense transitions were determined by counting the number of photoelectrons knocked out by the γ rays from thin targets of platinum (1.96 mg cm^{-2}), bismuth (0.5 mg cm^{-2}), and thorium (5.5 mg cm^{-2}). The multipolarities for the various transitions are listed. The γ-γ coincidences were counted on a 50 channel, NaI(Tl) scintillation counter having a resolving time of 5×10^{-7} sec. A decay scheme for Tm^{165} is presented. The ground state of Er^{165} has quantum characteristics of $5/2^-$ [523]. The 77.2-kev level is rotational in character. The 47.13-kev level has characteristics of $5/2^+$ [642], since the state $5/2^+$ is closest to the state $5/2^-$ [523] in Nielsson's scheme of levels. Quantum characteristics of $3/2^-$ are selected for the 243.0-kev level. The 296.2-kev level with quantum characteristics of $5/2^-$ is the first excited state of the rotational band based on the 243-kev level. Quantum characteristics of $1/2^-$ [521] are assigned to the 297.5-kev, rotational level. (TTT)

26491 THE CONVERSION ELECTRONS OF $Lu^{173, 174}$ IN THE ENERGY INTERVAL OF 540 TO 1450 kev. V. A. Balalaev, B. S. Dzhelepov, A. I. Medvedev, and I. F. Uchevatkin (Mendeleev All-Union Research Inst. of Metrology, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 200-3(Feb. 1963). (In Russian)

A long-lived lutetium fraction was isolated from a proton-irradiated Ta target, and the conversion electrons were determined on a $\pi\sqrt{2}$, double-focusing β spectrometer having a resolution of 0.35%. Besides the well-known conversion lines from the 558.1- and 636.8-kev γ transitions of Lu^{173}, two groups of conversion lines were clearly observed that could be identified as the K-, L-, and M-lines of the 994- and 1243-kev γ transitions of Lu^{174}. The count rate at the maximum of the K 1243 line was 0.40 coincidences min^{-1}. The upper level of the intensities of other electrons was ~0.05 of the intensity of the K 1243 electrons. The relative intensities of the conversion electrons of Lu^{173} and Lu^{174} are tabulated. (TTT)

26492 THE CONVERSION ELECTRON SPECTRA OF A CERIUM SPALLATION FRACTION. B. S. Dzhelepov,

A. I. Medvedev, I. F. Uchevatkin, and S. A. Shestopalova (Mendeleev All-Union Research Inst. of Metrology, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 204-10(Feb. 1963). (In Russian)

A mixture of cerium isotopes was isolated from a Ta target irradiated with 660-Mev protons. The conversion electron spectrum of the cerium fraction in the energy region of 210 to 1000 kev was determined on a magnetic β spectrometer having double focusing at an angle of 180°. The spectrum is complex, but most of the 42 conversion lines observed were identified and are tabulated. The identification of the lines was made by measuring the decrease in intensity with time. The cerium fraction was subjected to repeated purification to eliminate the interference from La^{135}. Most of the conversion lines could be assigned to Ce^{135}, whose half life was taken to be 17.0 ± 0.2 hours. The K/L ratio for the 265-kev γ transition was found to be 8.4 ± 1, and corresponds to the theoretical value for a transition of the E1 type. (TTT)

26493 THE ROTATIONAL NATURE OF THE 2.2 Mev LEVEL OF Al^{27}. D. G. Alhazov, K. I. Erokhina, and I. Kh. Lemberg. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 211-5 (Feb. 1963). (In Russian)

Ions of N^{14}, Ne^{20}, and Ne^{22} were used to excite the 2.2-Mev level in Al^{27}. The optimum excitation was obtained with 21-Mev nitrogen ions. Back-ground lines with energies of 2.3 and 2.8 Mev were ascribed to oxygen impurities due to the presence of an Al_2O_3 film. However, it was possible to resolve the γ spectrum by a method of trial and error. In calculating the $B(E2)\uparrow$ transition probability, the 0.56-Mev level in Se^{76}, and the 1.015-Mev level of Al^{27} were used as standards, for which the $B(E2)\uparrow$ values are respectively 0.48 and 0.0021 (in units of $e^2 \cdot 10^{-48}$ cm^4). The value of B(E2) for the 2.2-Mev level in Al^{27} was found to be 0.015 ± 0.06 $e^2 \cdot 10^{-48}$ cm^4. These data indicate on comparison with the data of Rusmussen et al. in Phys. Rev., 123: 1386-93 (1961) that the quantum characteristics of the 2.2-Mev level in Al^{27} are $^7/_2{}^+$, and that $\delta = (E2/M1)^{0.5} = +0.47$. It is proposed that the 2.2-Mev level in Al^{27} is rotational in nature, since the value of B(E2) for this level exceeds by a factor of 7 to 12 the value of B(E2) for transitions from the ground state to the first and second levels of Al^{27}. (TTT)

26494 THE Sm^{150} NUCLEAR LEVELS EXCITED IN AN (n,γ) REACTION. L. V. Groshev, A. M. Demidov, V. A. Ivanov, V. N. Lutsenko, and V. I. Pelekhov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 216-27(Feb. 1963). (In Russian)

The energies and γ intensities of Sm^{150} were determined after irradiating a 72 gram sample of Sm_2O_3 (natural mixture of isotopes) with thermal neutrons. The γ rays carry off ~21% of the total energy given off during neutron capture. The internal electron conversion spectrum was determined on a magnetic spectrometer (resolution of 0.6%) with the use of an enriched Sm_2O_3 sample containing 94.6% Sm^{149}. Values of the internal conversion coefficient α_K were calculated from the γ intensities with respect to the theoretical value for the 439-kev transition (an E2 transition). The multipolarities of a number of transitions were tabulated on the basis of values of α_K and α_K/α_L. A scheme of the various levels in Sm^{150} is presented. The 334-kev level has characteristics of 2^+, and the value of B(E2, $0^+ \rightarrow 2^+$) is 1.32 $e^2 \cdot 10^{-48}$ cm^4. The 740-kev with a characteristic of 0^+ is weakly populated by an (n,γ) reaction (<1.3% per neutron capture). The 773-level with a characteristic of 4^+ is de-excited by a 439-kev transition to the 334-kev level. This level is very intensely populated by an (n,γ) reaction (54% per neutron capture). The 1047-kev level has a characteristic of 2^+, and transitions from this level to the levels at 740 and 773 kev are accompanied by 307- and 276-kev lines in the internal electron conversion spectrum. The 1048 transition is of an E2 type. The 1071-Mev level has a characteristic of 3^-, and the 1167-kev level was assigned a characteristic of 2^+. The 1256-kev level has a characteristic of 0^+, and the 1278-kev level has a characteristic of 6^+. The characteristics of higher-energy levels were assigned on the basis of the multipolarities of the transitions to the 773-kev level having a characteristic of 4^+, and of transitions to the first excited level. The nuclear levels in Sm^{150} were compared with those of Gd^{152}, and it was found that the transitions in these two nuclei are similar. (TTT)

26495 THE INTERPRETATION OF NUCLEAR LEVELS IN THE ODD-ODD ISOTOPE P^{30} ACCORDING TO THE S. NIELSSON MODEL. A. K. Val'ter, E. G. Kopanets, A. N. L'vov, and S. P. Tsytko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 228-31(Feb. 1963). (In Russian)

The nuclear levels of P^{30} were compared with the levels of the isobaric nucleus Si^{30}, and with the levels of neighboring nuclei having odd A such as P^{31}, P^{29}, and Si^{29}. A number of the lower-lying levels of P^{30} were interpreted according to the model of S. Nielsson. On comparing the 2.94-Mev level in P^{30} with the 2.24-Mev level in Si^{30}, it could be seen that these levels are comparable not only in values of the spin and parity (2^+), but also in isotopic spin (T = 1). By analogy, it can be assumed that the 2.94-Mev level in P^{30} is rotational in nature. A comparison of the 1.97-Mev excited state in P^{30} with the positions of the first excited level of nuclei with odd A indicated that the 1.97-Mev level in P^{30} is single-particle in nature with quantum characteristics of 2^+ (parallel orientation of the proton and neutron spins). The P^{30} levels below 1.97 Mev are interpreted as rotational bands with quantum numbers K = 0.1 and 2. Experimental data on the relative probabilities of γ transitions of eight resonance states of P^{30} were satisfactorily explained by the collective model of Nielsson for deformed nuclei. (TTT)

26496 A STUDY OF THE γ-RAYS CORRESPONDING TO THE 1308 kev RESONANCE IN THE $Si^{29}(p,\gamma)P^{30}$ REACTION. A. K. Val'ter, E. G. Kopanets, A. N. L'vov, and S. P. Tsytko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 232-4(Feb. 1963). (In Russian)

Monoenergetic protons, and an isotopic target of Si^{29} were used to study the 1308-kev resonance, for which the γ spectrum, and angular distribution of γ rays were determined. Standard spectra shapes for definite γ lines were studied in order to resolve the complex γ spectrum. The angular distribution of γ rays for the most intense γ transition (54%) from the 6.827-Mev resonance level to the first, excited, 0.684-Mev state was used to determine the spin and parity of the resonance level. The final state has a spin and parity of 0^+, while the angular distribution is isotropic. Hence, a spin and parity of $I^\pi = 1^+$ was assigned to the 6.827-Mev resonance level. A decay scheme is presented for the P^{30} resonance state having an excitation energy of 6.827 Mev. An analysis of the decay scheme and of the observed γ transitions showed that the isotopic spin T = 0. The 2.94-Mev state of P^{30} with a spin and parity of 2^+ goes by γ transition to the first, excited, 0.684-Mev level with a greater relative probability (10%), than to the ground state of P^{30} with a spin and parity of $I^\pi = 1^+$ (~2%). Such behavior indicated that this state in P^{30} is rotational in nature. (TTT)

26497 AN ANALYSIS OF THE β-DECAY OF Bi^{210} (RaE), Pb^{210} (RaD), AND Pb^{209}. THE WAVE FUNCTION OF RaE. L. N. Zyryanova and V. M. Mikhailov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 235-45(Feb. 1963). (In Russian)

The decay of RaE is characterized by a difference in the shape of the β spectrum from that of an allowed one, and by a deviation in polarization from a v/c rule. In β transitions of the type $1^- \rightarrow 0^+$, matrix elements of third order forbiddenness, which are usually neglected, can make a contribution according to the selection rules. The form factor for a β transition of the type $1^- \rightarrow 0^+$ was calculated by taking into account terms of I and III order forbiddenness. The results show that the parameter x, which includes the nuclear matrix elements, can be allowed to vary to a value of 3.0 instead of 2.0, if III order forbiddenness is taken into account. The contribution of III order forbiddenness is small at small values of x, but increases at large values of x. The parameters x and y obtained from an analysis of the shape of spectrum and of the polarization are related in a definite way to the wave functions of the initial and final states. The theoretical values of ft for the decay of RaD to the ground state of Bi^{210} (RaE), and to the first excited level with quantum characteristics of 0^- were derived, and shown to be in good agreement with the experimental ft values. (TTT)

26498 A STUDY OF THE NEUTRON-DEFICIENT ISOTOPES OF Lu ON A PRISM SPECTROMETER WITH QUADRUPOLE LENSES. V. V. Tuchkevich, V. A. Romanov, and M. G. Totubalina (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 246-8(Feb. 1963). (In Russian)

A lutetium fraction was separated from a tantalum target irradiated with 660-Mev protons for a period of two hours. A large-prism β spectrometer with quadrupole lenses gave good resolution of the conversion electrons because of the large solid angle and high dispersion at a small source height. The L_I:L_{II}:L_{III} ratio for the 181.6-kev γ transition in Lu^{172} was 0.57:1.21:1, and indicated an E2 transition. The 203.4-kev transition went to the first level of the upper rotational band, and the L_{II}:L_{III} ratio indicated an E2 transition. The 269.8-kev γ transition from the 2075-kev level to the 1805-kev level indicated an M1 multipolarity with a small admixture of E2(<10%) from the L_I:L_{II} ratio of intensities = 1:1.15. The 191.4-kev transition in Lu^{169} was found to have an M1 multipolarity with an E2 admixture of <15%, as determined from measurements of the internal conversion electrons on the β spectrometer with quadrupole lenses. The energy of this transition was 191.25 ± 0.08 kev. (TTT)

26499 THE RELATIVE INTENSITIES OF THE γ-LINES OF Ga^{72}. V. D. Vitman, N. A. Voinova, and B. S. Dzhelepov (Mendeleev All-Union Research Inst. of Metrology, USSR and Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad Nauk SSSR, Ser. Fiz., 27: 249-57(Feb. 1963). (In Russian)

An elotron, which is a magnetic γ spectrometer utilizing the recoil electrons knocked out of a thin target by the γ rays, was used to determine the relative intensities of γ lines in Ga^{72}. The resolution of the instrument was high (a relative halfwidth of 1% for 1.5-Mev γ rays, and 1.8% for 0.6-Mev γ rays), but about 2 to 6 curies of Ga^{72} were required for an analysis because of the low counting efficiency due to the small solid angle subtended by the source. A 0.72 gram sample of Ga_2O_3 was irradiated 15 to 25 hours at a neutron flux of about 5×10^{13} neutrons cm^{-2} sec^{-1} to obtain the necessary activity. The ratio of intensities of 835- and 2205-kev γ lines was used to determine the activity of Ga^{72} in the source. The energies of the γ lines were known to 0.2% by calibrating the instrument with the 411-kev line of Au^{198}, the 661-kev line of Cs^{137}, the 890- and 1118-kev lines of Sc^{46}, the 1172- and 1332-kev lines of Co^{60}, and the 1368- and 2754-kev lines of Na^{24}. The relative intensities and energies of the γ rays of Ga^{72} are tabulated, and compared with the data of Mitchell et al. in Phys. Rev., 73: 1424(1948), the data of Johns et al. in Phys. Rev., 99: 1645A(1955), and the data of Kraushaar et al. in Phys. Rev., 101: 139(1956). A number of lines not previously reported were detected due to the improved resolution of the instrument. (TTT)

26500 INTERNAL CONVERSION WITH PAIR FORMATION DURING THE DECAY OF Br^{82}. N. B. Badalov, S. S. Vasilenko, M. G. Kaganskii, and D. L. Kaminskii (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 258-9(Feb. 1963). (In Russian)

$MgBr_2$ was irradiated with thermal neutrons, and mounted on an Al foil 5μ thick for counting on a spectrometer having an efficiency of 1.2% of 4π, and a resolution of ~1.2%. The 10 min activity due to Mg^{27} was allowed to decay out before counting the 35.9 hr activity of Br^{82}. The positron spectrum clearly shows the 1313- and 1478-kev transitions. On comparing areas under the positron and electron spectra, it was found that the intensity of positron emission was 2.16×10^{-5} positrons per disintegration. The multipolarities of the transitions were determined by comparing the positron spectra with the corresponding internal conversion electron lines for the K-shell. It was found that the 1313- and 1478-kev transitions were transitions of the type E2 or M1. (TTT)

26501 INTERNAL CONVERSION WITH PAIR FORMATION DURING THE DECAY OF As^{76}. N. B. Badalov, S. S. Vasilenko, M. G. Kaganskii, and D. L. Kaminskii (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 260-2(Feb. 1963). (In Russian)

As_2O_3 was irradiated with thermal neutrons, and mounted on an Al foil 5μ thick for counting on a double-focusing spectrometer having an efficiency of 1.2% of 4π, and a resolution of ~1.2%. The area of the source was 10 × 30 mm, and its thickness was 2 to 3 mg cm^{-2}. The spectrum has a complex form due to internal conversion positrons with pair formation at transitions having energies of 1230, 1500, 1795, 1970, and 2115 kev. The 1500- and 1970-kev transitions were not previously reported. The number of positrons per disintegration was found to be 1.1×10^{-5}. The positron spectrum was resolved into its five component parts, and the energies and intensities of the positron components were determined. The multipolarities of the transitions were determined by comparing the calculated and experimental values of the pair conversion coefficient. The transitions at 1230, 1795 and 2115 kev are quadrupole transitions of type E2. (TTT)

26502 A STUDY OF THE INTERNAL ELECTRON CONVERSION SPECTRUM OF Eu^{147}. O. D. Kovrigin, V. M. Kartashov, G. D. Latyshev, G. A. Londarenko, A. F. Novgorodov, G. I. Sychikov, and V. V. Shapovalenko. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 263-6(Feb. 1963). (In Russian)

A gadolinium fraction containing Gd^{147} ($T_{1/2}$ = 1.5 d) was isolated from a Ta target irradiated with 660-Mev protons. Eight days later the Eu^{147} daughter ($T_{1/2}$ = 24 d) was separated from the Gd^{147} parent, and mounted electrolytically on a copper backing. The internal conversion electron spectrum of Eu^{147} was determined on a large, double-focusing, magnetic β spectrometer. The Eu^{149} impurity was insignificantly small. A comparison of the experi-

mental and calculated values of the internal conversion electron coefficients α_K/α_L showed that the 77-kev γ transition is a transition of the type M1 + 15% E2, and that the 602- and 679-kev transitions are M1 and E2, or E2 and M3 respectively. The K-LL, K-LM, and K-MM Auger electrons were readily resolved, and the theoretical values for the relative intensities of these groups of Auger electrons were found to be in good agreement with the experimental values. (TTT)

26503 THE PROBABILITY OF γ-TRANSITIONS FROM LEVELS OF A BAND WITH $K = 3^+$ TO LEVELS OF THE PRINCIPAL ROTATIONAL BAND. AN ANALYSIS OF TRANSITIONS OF THIS TYPE IN Yb^{172}. B. S. Dzhelepov and V. M. Mikhailov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 267-82(Feb. 1963). (In Russian)

Direct transitions of the type M1 or E2 from excited states with $K^\pi = 3^+$, 4^+ and higher to levels of the rotational bands of the ground state ($K = 0^+$) are forbidden by the selection rules for the quantum number K. For allowed transitions, the multipolarity l should satisfy the inequality $l \geq |K_i - K_f|$. Transitions of the type M3, M4, etc. are allowed, but they should occur much more slowly than is observed in practice. Therefore, it is natural to propose that there are not only components with other values of K in the wave functions of the participating states. In Yb^{72}, all the identified excited states decay to five rotational bands with $K^\pi = 3^+$ for the 1174-kev, $K^\pi = 2^+$ for the 1467.5-kev, $K^\pi = 3^+$ for the 1664.3-kev, $K^\pi = 3^+$ for the 1702.1-kev, and $K^\pi = 4^+$ for the 2075.0-kev levels, and to five separate states of 1600 (1^-), 1864.3 (4^+), 1932.1 (5^+), 1979.6 (3^+), and 2287.3 kev (4^+). Transitions between bands with $K^\pi = 3^+$ and $K^\pi = 0^+$ caused by an impurity with $K^\pi = 2^+$ are considered. The formulas for the relative intensities of the competing transitions are written, and the multipolar composition of the transitions is estimated. The probabilities of various transitions are compared. (TTT)

26504 THE CONTRIBUTION OF THIRD-ORDER FORBIDDENNESS TO THE SPECTRUM AND POLARIZATION OF β-ELECTRONS OF RaE. N. N. Popov (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 283-5(Feb. 1963). (In Russian)

The form factor of the beta spectrum, and the longitudinal polarization of the β particles from RaE can be calculated for a β transition of first order forbiddenness at values of $0.2 < x < 1.2$, where $x = (iC_v \int r/C_a \int \tilde{\sigma} xr)$. Here $\int r$ and $\int \tilde{\sigma} xr$ are nuclear matrix elements, and C_v and C_a are constants of the β interaction. Values of $x > 1.2$ for RaE can be obtained due to a mixture of configurations $(h_{9/2} i_{13/2})$ and $(h_9 g_{9/2})$ in the ground state of RaE. The RaE β transition is of first order forbiddenness ($1^- \rightarrow 0^+$), and the selection rules $\Delta j = 1$ allow a contribution of third order forbiddenness, which may be substantial due to the compensatory nature of the main terms of first order forbiddenness. Formulas for the form factor of the spectrum, and the longitudinal polarization of the β particle are presented, where the correction due to third order forbiddenness is taken into account. The correction of third order forbiddenness makes the largest contribution to the form factor of the spectrum at large values of x. Contributions from the next higher order of forbiddenness allowed by the selection rules may turn out to be substantial, when the form of the electron spectrum is anomalous, or the longitudinal polarization of the β particles is out of the ordinary, and differs from a v/c relation. (TTT)

26505 THE γ-RAY SPECTRUM FOR THE DECAY OF Eu^{150}. G. A. Kotel'nikov and N. Shadiev. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 286-9(Feb. 1963). (In Russian)

The radioactive decay of Eu^{150} to Sm^{150} is of interest in finding new levels in Sm^{150} which cannot be detected by a (n,γ) reaction on Sm^{149}. The Eu^{150} activity ($T_{1/2}$ = 14 hr) was prepared by bombarding an enriched Sm^{150} target with 10-Mev protons on a cyclotron. The europium activity was isolated by ion exchange separation. The γ spectrum of Eu^{150} was measured on a scintillation spectrometer. The γ-γ coincidences were followed on a two-crystal spectrometer with a fast-slow coincidence arrangement, and a summing circuit. The resolving time of the fast coincidence circuit was 1.5×10^{-8} sec. The energies and relative intensities of the γ rays are listed. A decay scheme for Sm^{150} is presented. The data agree with that of Harmatz et al. in Phys. Rev., 123: 1758(1961) with the exception that an additional level having an energy of 1050 kev was introduced. The data also agree in general with that of Ricci et al. in Nucl. Phys., 32: 490(1962). (TTT)

26506 THE PROPERTIES OF ODD, AND ODD-ODD NUCLEI WITH $Z > 55$, AND $N < 75$. L. K. Peker and Yu. N. Novikov (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 295-300(Feb. 1963). (In Russian)

The value of a parameter μ, characterizing the magnitude of the spin-orbital interaction, is required to calculate the wave function and succession of levels according to Nielsson's diagram. An analysis of the data available for the decay chain $La^{131} \rightarrow Ba^{131} \rightarrow Cs^{131}$ indicated that the parameter $\mu = 0.45$, and that the nuclei Ba^{131} and La^{131} are deformed. The best agreement with the experimental data was obtained in calculating the magnetic moments of Cs^{127} and Cs^{129} with $\mu = 0.45$. The predicted values of the magnetic moments were too high with $\mu = 0.55$. The conversion electron spectrum for the decay of Ba^{129} to Cs^{129} was complex, but the assignment of levels was considerably simplified if it was assumed that Cs^{129} is a deformed nucleus, and that $\mu = 0.45$. The Nielsson diagram gave the approximate order of single-particle levels, and each single-particle level should have a rotational band associated with it. A level scheme is presented for the decay of Ba^{129} to Cs^{129}. A diagram of single-particle levels for nuclei such as Cs^{126}, Cs^{128}, and Cs^{130} is given. Apparently, an odd proton occupies the level $1/2^+$, and an odd neutron occupies the level $1/2^+$. The available data indicated that a new region of deformed nuclei exists in this case. (TTT)

26507 NEUTRON-DEFICIENT ISOTOPES OF YTTRIUM AND ZIRCONIUM. F. D. S. Butement and G. B. Briscoe (Univ. of Liverpool). J. Inorg. Nucl. Chem., 25: 151-7(Mar. 1963).

Two new activities were found in the neutron-deficient isotopes of yttrium produced by (p,pxn) reactions on yttrium. The half lives were determined as 34.7 ± 1.6 min and 12.3 ± 0.2 min. The activities are assigned to Y^{83} and Y^{82}, respectively, on the basis of their genetic relations with strontium isotopes. The half lives of Y^{85} and Y^{84} were re-determined as 3.4 hr and 2.6 ± 0.5 hr, respectively. A new activity with a half life of 6 min was assigned to Zr^{86}, and two new γ rays were found to be associated with the decay of Zr^{87} and Sr^{83}. (auth)

26508 CONVERSION COEFFICIENT FOR THE Ir^{192m} TRANSITION. B. Keisch (Phillips Petroleum Co., Idaho Falls, Idaho). J. Inorg. Nucl. Chem., 25: 220-1(Mar. 1963).

The conversion coefficient α for the 57-kev transition in the decay of the 1.45-min isomer Ir^{192m} was measured indirectly by means of the yield ratio for the isomer pair Ir^{192m} and Ir^{192}. The measurements gave an average α value of 3400 ± 300. (D.L.C.)

26509 FISSION OF ^{232}Th BY REACTOR NEUTRONS: MASS-YIELD CURVE. R. H. Iyer, C. K. Mathews, N. Ravindran, K. Rengan, D. V. Singh, M. V. Ramaniah, and H. D. Sharma (Atomic Energy Establishment, Trombay, India). J. Inorg. Nucl. Chem., 25: 465-72(May 1963).

Fission yields of thirty nuclides covering the mass region 77 to 156 were determined for the fission of Th^{232} by neutrons from the swimming-pool reactor "Apsara," using radiochemical techniques. The mass-yield curve has the two familiar peaks at mass numbers 90 and 140. The maximum peak yield is about 8% and minimum trough yield about 0.03%. The yield data indicate the presence of a small third peak in the symmetric region of the mass-yield curve. The third peak is about 0.5% of the total mass-yield curve and has a maximum to minimum ratio of about 2.4 and a half-width of about seventeen mass numbers. The data obtained were compared with similar data in literature. The results are discussed in the light of two-mode-fission hypothesis. (auth)

26510 CALCULATION OF THE ACTIVITIES OF RADIOISOTOPES PRODUCED DURING PERIODICAL IRRADIATION. Ferenc Molnar. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 139-46(1963). (In Hungarian)

A scheme is presented that under given conditions of activation facilitates the calculation of the activities to be expected for isotopes produced by irradiation with varying flux. (auth)

26511 NUCLEAR POTENTIAL IN QUANTUM FIELD THEORY. C. H. Lee (Univ. of Edinburgh). Nucl. Phys. 43: 177-86(May 1963) (In English)

It is proposed to use the Low equation to define the potential between two nucleons. The work is entirely within the framework of axiomatic quantum field theory. (auth)

26512 DISINTEGRATION OF Te^{119} ISOMERS. J. Kantele (Univ. of Arkansas, Fayetteville) and R. W. Fink. Nucl. Phys., 43: 187-203(May 1963). (In English)

The decay of Te^{119} isomers was studied with highly mass-separated sources by scintillation techniques, including sum-peak coincidence spectrometry. The half-life of Te^{119m} was measured to be 4.68 ± 0.05 d. A new gamma at 702 ± 10 kev with an intensity of 13% of that of the well-known 645 kev gamma was found in the 16 h Te^{119g} decay. In the decay of the 4.7 d state the following new gammas were found: 1050 ± 20, 1135 ± 15, and 1374 ± 10 kev. The absence of gammas at 1500, 1760-1780, 1900, 2350, and 2570 kev reported in the literature is suggested by setting upper limits on their intensities. From the present results a decay scheme is proposed that accounts for essentially all of the observed data, and in which the first excited state in Sb^{119} lies at 271 kev, in agreement with the probable level systematics of odd-mass antimony isotopes. The total disintegration energy of the 4.7 d Te^{119m} was measured to be 2.6 ± 0.1 Mev. (auth)

26513 SMALL-ANGLE ELASTIC SCATTERING OF PROTONS ON CARBON NUCLEI AT 660 Mev. L. S. Azhgirey, Yu. P. Kumekin, M. G. Mescheryakov, S. B. Nurushev, G. D. Stoletov, and De-tsang Huang (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 43: 213-28(May 1963). (In English)

The differential cross sections for the elastic scattering of protons by carbon nuclei and the proton polarization in this process were measured in the interval $1.8° \leq \theta \leq 9°$ at 660 Mev. Using a magnetic analysis, elastic proton scattering was separated from inelastic scattering. The best values of the real and imaginary parts of the spin-independent and spin-dependent forward scattering amplitudes were obtained. The values of the integrated optical potentials were given. The values of r.m.s. radii for the central and spin-orbit potentials were deduced to be equal to 2.48 ± 0.04 and 2.83 ± 0.16 fm. The spin-orbit interaction at 660 Mev is found to be smaller than that at 310 Mev. Conclusions are drawn on the complex value of the spin-orbit potential of the nucleon-nucleus interaction at 660 Mev. (auth)

26514 EXCITATION OF THE ELECTRIC DIPOLE GIANT RESONANCE BY INELASTIC ELECTRON SCATTERING AT 180°. J. Goldemberg, Y. Torizuka, W. C. Barber, and J. D. Walecka (Stanford Univ., Calif.). Nucl. Phys., 43: 242-53(May 1963). (In English)

The cross section for the excitation of the nuclear giant resonance by electrons is calculated in a model in which the protons are assumed to oscillate as a unit against the neutrons. The longitudinal component of the field of the electrons is shown to have a cross section that agrees with results obtained previously by Fallieros, Ferrell and Pal. The transverse component is shown to have a form factor proportional to the elastic scattering form factor. Preliminary measurements in C, Al, and Kr with 41.5 Mev electrons scattered at 180°, where only the transverse component is present, show cross sections smaller by about a factor of four than the calculated ones. For C and Al, these results are not surprising, because the Goldhaber-Teller model predicts a γ-absorption cross section that exhausts the dipole sum-rule and photonuclear experiments have shown that light elements fall considerably short of this. The discrepancy in the case of Kr could result from the failure of the Born approximation used in the theory. Another interesting possibility is that the Goldhaber-Teller model previously thought to be a fairly good description of the giant resonance in medium and heavy nuclei, is not correct in detail. (auth)

26515 LEVELS IN Sm^{148} FED IN THE BETA-DECAY OF Pm^{148} AND Pm^{148m}. C. V. K. Baba, G. T. Ewan, and J. F. Suarez (Universitet, Copenhagen). Nucl. Phys., 43: 264-84(May 1963). (In English)

The disintegration schemes of 5d Pm^{148} and 41d Pm^{148} were studied using a six-gap β-spectrometer, scintillation spectrometers, e-γ, β-γ, and γ-γ coincidences and γ-γ angular correlation techniques. Levels are established in Sm^{148} at energies in kev of $0(0^+)$, $551(2^+)$, $1162(3^-)$, $1181(4^+)$, $1465(1^-)$, $1595(5^-)$, $1908(6^+)$, $2097(6^+)$, and $2196(6^+)$. The spin assignments are based on a combination of the γ-γ angular correlation results and the multipolarities of the gamma transitions deduced from the K-conversion coefficients. Levels in Pm^{148} are observed at $0(1^-)$, $62(2^-)$, and $138(6^-)$ kev. The 41d activity proceeds ≈93% to levels in Sm^{148} and ≈7% to the 5d ground state of Pm^{148}. (auth)

26516 LEVELS IN Sm^{148} FED IN THE DECAY OF Eu^{148}. C. V. K. Baba, G. T. Ewan, and J. F. Suárez (Universitet, Copenhagen). Nucl. Phys., 43: 285-302(May 1963). (In English)

The disintegration scheme of 54 d Eu^{148} was studied using a six-gap β-ray spectrometer, scintillation spectrometers, and e-γ, β^+-γ and γ-γ coincidence techniques. Levels are established in Sm^{148} at energies (in kev) of $0(0^+)$, $551(2^+)$, $1162(3^-)$, $1181(4^+)$, $1595(5^-)$, $1735(3,4^+)$, $1896(3^-)$, $1908(6^+)$, $2035(4^-)$, $2097(6^+)$, $2147(5^+)$, $2196(6^+)$, $2215(5^+)$, $2735(4,5^-)$, and $2803((4,5)^-)$. The spin assignments are based on measured multipolarities of the transitions, combined with the known spins of some of the levels established in the study of the decay of Pm^{148}. A β^+-γ coincidence experiment es-

tablished a weak positron feed of (0.13 ± 0.04)% to the 1162 kev level and/or the 1181 kev level. The total decay energy of Eu^{148} is 3110 ± 50 kev. (auth)

26517 ISOBARIC ANALYSIS OF TOTAL BETA DECAY ENERGIES. John W. Dewdney (Dartmouth Coll., Hanover, N. H.). Nucl. Phys., 43: 303-15(May 1963). (In English)

An analysis was made of the total beta decay energies that follow from the nucleidic masses determined by Everling et al. and revised by König, Mattauch and Wapstra. At all mass numbers for which there are known at least 3 beta decay energies, a weighted least squares procedure was used to determine, with standard errors, the following isobaric properties of the mass surface: the separation of the parabolas, the location of the common minimum of the two parabolas, and the common breadth of the parabolas. The dependence on mass number of these properties is discussed in terms of nuclear shell structure. (auth)

26518 ANGULAR DISTRIBUTIONS OF FAST NEUTRONS SCATTERED ON ALUMINUM. D. Winterhalter (Inst. "Rudjer Boskovic", Zagreb and Univ. of Zagreb). Nucl. Phys., 43: 339-43(May 1963). (In English)

Angular distributions for the scattering of 2.76 Mev neutrons by aluminum were studied using nuclear emulsions as detectors. The results for elastic scattering were interpreted in relation to the applicability of the compound nucleus model and of the optical model. The angular distribution of inelastically scattered neutrons resulting in the excitation of two lower nuclear levels was determined. The angular distribution obtained for inelastically scattered neutrons from the 1.013 Mev state is anisotropic and forward peaked, while it is approximately isotropic for the 1.91 Mev state. (auth)

26519 RESONANCE SCATTERING OF BREMSSTRAHLUNG BY THE 2.14 Mev STATE OF B^{11}. V. J. Vanhuyse and G. J. Vanpraet (Rijksuniversiteit, Ghent). Nucl. Phys., 43: 344-7(May 1963). (In English)

The bremsstrahlung spectrum of 3.0 Mev electrons of a linear accelerator was used to observe resonant scattering of photons by the 2.14 Mev excited state of B^{11}. A self-absorption method was used to define the mean life τ of this level. The value $\tau = (3.0 \pm 0.8) \times 10^{-15}$ sec is obtained. (auth)

26520 THE HALF-LIFE AND RADIATIONS OF Kr^{76}. I. Dostrovsky and R. W. Stoenner (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys., 43: 348-52(May 1963). (In English)

The half-life of Kr^{76} was determined by parent-daughter separation and by growth and decay of Br^{76}. The value of $t_{1/2} = 14.8 \pm 0.1$ h was obtained. Observation of the γ spectrum indicated peaks at ≈ 0.040, 0.073, 0.104, 0.135, 0.197, 0.267, 0.316, 0.360, 0.407, and 0.452 Mev. The most prominent γ rays are those at ≈ 0.040, 0.267, and 0.316 Mev. The rate of decay of the γ spectrum gave a half-life in reasonable agreement with that determined above. The Kr^{76} nucleus seems to decay almost entirely by electron capture. (auth)

26521 NEUTRON CAPTURE CROSS SECTIONS NEAR 30 kev USING A MOXON-RAE DETECTOR. R. L. Macklin, J. H. Gibbons, and T. Inada (Oak Ridge National Lab., Tenn.). Nucl. Phys., 43: 353-62(May 1963). (In English)

Neutron radiative capture cross sections were measured using a Moxon-Rae detector, for neutrons near 30 kev. A time-of-flight system with less than 3 ns resolution and a 7 cm flight path was shown applicable to small sample measurements. Cross sections at 30 kev for Mo, Cd, Sn, Ta, W, Pt, and Au and cross sections versus energy for fluorine, sulfur, and yttrium are presented. (auth)

26522 CASCADE CALCULATION FOR K^- MESIC ATOMS. J. R. Rook (Oxford Univ.). Nucl. Phys., 43: 363-6(May 1963). (In English)

The competition between x ray and Auger emission and nuclear absorption in the decay of K^- mesic atoms is calculated. It is suggested that nuclear capture occurs from states with high angular momentum but probably not from circular states. (auth)

26523 LIFETIME OF THE 21.7 kev STATE IN Eu^{151}. D. J. Horen, H. H. Bolotin, and W. H. Kelly (Univ. of California, Berkeley). Nucl. Phys., 43: 367-71(May 1963). (UCRL-10592). (In English)

Using sodium iodide detectors and a time-to-height converter, the half-life of the 21.7 kev state in Eu^{151} was measured as (9.5 ± 0.5) ns. The 21.7 kev, l-forbidden M1 transition is found to have a hindrance factor of 118. These results indicate that in the approach to the deformed region, the hindrance factors for the l-forbidden M1 transitions from the first excited state to the ground state in Eu^{147}, Eu^{149}, and Eu^{151} do not decrease monotonically, as was previously suggested. (auth)

26524 VELOCITY DEPENDENT NUCLEON-NUCLEON INTERACTIONS AND THE GROUND STATE OF NUCLEAR MATTER. F. Peischl (Technische Hochschule, Munich) and E. Werner. Nucl. Phys., 43: 372-92(May 1963). (In English)

The binding energy per particle of nuclear matter is computed within the independent pair theory with the assumption of a simple velocity dependent nucleon-nucleon force. Non-central interactions are neglected, the central interaction is assumed to act only in even parity states. The square well approximation for the radial shape of the potential is used. The independent pair theory predicts a saturation density that corresponds to $k_f = 1.47$ fm^{-1} and a binding energy per particle of $\epsilon = -15.1$ Mev. A calculation using the Hartree-Fock approximation gives $k_f = 1.56$ fm^{-1} and $\epsilon = -13.3$ Mev. (auth)

26525 g-FACTOR MEASUREMENT ON THE FIRST EXCITED STATE OF Fe^{56} USING INTERNAL MAGNETIC FIELDS. H. Appel and W. Mayer (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Phys., 43: 393-404(May 1963). (In English)

The g-factor of the 0.845 Mev (2^+) level of Fe^{56} was measured by observing the rotation of the γ-γ angular correlation of the 4^+-2^+-0^+ cascade due to internal magnetic fields in iron. The result is $g = 0.58 \pm 0.17$. (auth)

26526 THE SCATTERING OF ALPHA PARTICLES BY CARBON, OXYGEN, MAGNESIUM AND GOLD. H. F. Lutz, J. B. Mason, and C. T. Paulson (Univ. of California, Livermore). Nucl. Phys., 43: 405-12(May 1963). (UCRL-7063). (In English)

Differential cross sections for the scattering of alpha particles by C, O, Mg, and Au at 60° in the laboratory system were measured over the energy range 13 to 30 Mev. All curves exhibit fluctuations from the smooth behavior predicted by the optical model. In the case of Au it is shown that the optical model gives the average behavior of the differential cross section. (auth)

26527 EXCITED STATES IN N^{14} FROM C^{12} + d REACTIONS. J. M. F. Jeronymo, G. S. Mani, F. Picard, and A. Sadeghi (CEN, Saclay, France). Nucl. Phys., 43: 417-23(May 1963). (In English)

The excitation curves for the reactions $C^{12}(d,d)C^{12}$, $C^{12}(d,p_0)C^{13}$, $C^{12}(d,p_1)C^{13*}$, $C^{12}(d,p_2)C^{13*}$, and $C^{12}(d,p_3)C^{13*}$ were measured at two angles, 143.5 and 155° in the laboratory system, for deuteron energies from 0.9 to 5.0 Mev.

The data give evidence for a large resonant contribution in deuteron reactions with C^{12} even at 5 Mev. A number of new levels were found in N^{14} at excitation energies from 11 to 15 Mev. (auth)

26528 THE $Li^6(p,\alpha)He^3$ REACTION. J. M. F. Jeronymo, G. S. Mani, and A. Sadeghi (CEN, Saclay, France). Nucl. Phys., 43: 424-9(May 1963). (In English)

The $Li^6(p,\alpha)He^3$ reaction was studied up to 5 Mev proton energy. The excitation curve and angular distributions were measured from 2.0 to 5.0 Mev proton energy in steps of about 100 kev. The possible existence of a positive parity state of Be^7 around 4.0 Mev proton energy is indicated. (auth)

26529 RADIATIVE CAPTURE OF μ^--MESONS BY NUCLEI. G. A. Lobov (Inst. of Theoretical and Experimental Physics, Moscow). Nucl. Phys., 43: 430-7(May 1963). (In English)

The spectrum and circular polarization of photons are calculated for the radiation capture of mesons (μ^-) by medium-heavy nuclei, taking into account the Coulomb field in the intermediate state of the meson (μ^-). The Coulomb field of the nucleus for any Z is taken into account with the aid of a Green function in the Coulomb field. The reaction ${}_6C^{12} + \mu^- \rightarrow {}_5B^{12} + \nu + \gamma$ is discussed. (auth)

26530 COLLECTIVE VIBRATIONS OF SPHEROIDAL EVEN NUCLEI. E. R. Marshalek and J. O. Rasmussen (Universitet, Copenhagen). Nucl. Phys., 43: 438-71(May 1963). (In English)

An extension of the Inglis cranking model, in which nuclear shape oscillations are described without the adiabatic approximation, is derived and applied to quadrupole vibrations of spheroidal nuclei, with special emphasis on γ vibrations. This method leads to a dispersion formula for the collective frequencies agreeing in form with the frequency formula given by the Sawada method. Collective γ-vibrational frequencies and electric quadrupole transition probabilities are theoretically estimated for rare earth and actinide isotopes and compared with experimental values. The numerical calculations involve use of Nilsson's single-particle eigenvalues and the asymptotic eigenfunctions, pairing correlations being taken into account by means of the method of Bardeen, Cooper and Schrieffer, and of Bogolyubov. (auth)

26531 INTERMEDIATE COUPLING IN THE ASYMMETRIC ROTATOR MODEL. Robert F. Redmond (Battelle Memorial Inst., Columbus, Ohio). Nucl. Phys., 43: 472-89(May 1963). (In English)

The asymmetric rotator model of Davydov and Filippov for maximum asymmetry was extended to odd-mass nuclei by coupling the odd nucleon to the deformed equilibrium shape of the even-mass nuclear core. Intermediate coupling is considered where the odd nucleon has available to it $s_{1/2}$ and $d_{5/2}$ single particle states. It is shown that the interaction matrix elements connecting the 0^+ ground state and 2^+ first excited state of the even-mass core are identical with those obtained with the vibrational model. Hence for weak or intermediate coupling, there is little difference between the asymmetric rotator model and the vibrational model. As the coupling becomes strong, it is practical to follow the transition to the strong coupling limit with the asymmetric rotator model whereas this is not practical in general with the vibrational model. Expressions for the magnetic dipole moment and the M1 and E2 transition probabilities are derived for states of the coupled system of the odd-mass nuclei. Important interference effects are found in the B(E2) expression and the B(E2) values are found to be sensitive to the coupling strength. Calculations are made for these quantities for various parameter values that enter into the model. Data for several odd-neutron nuclei, Sn^{117}, Sn^{119}, Te^{122}, Te^{125}, and Xe^{129}, are then interpreted in terms of the model. There is enough freedom in the choice of parameters to ensure that the theoretical results and experimental data are not inconsistent in most cases. However, serious inconsistencies in the cases Sn^{119} and Te^{123} show that the model of the asymmetric rotator is not nearly as successful for odd-mass nuclei as it was for even-mass nuclei. This raises the interesting question whether the vibrational model with strong coupling can overcome these inconsistencies, or whether the coupling term in the Hamiltonian needs to be modified: perhaps by an additional interaction term of the form $J \cdot j$ employed by Davydov, where J and j are the core and odd nucleon angular momenta, respectively. (auth)

26532 MEASUREMENT OF THE MEAN LIFE OF THE 619 kev LEVEL IN Ta^{181}. H. Vartapétian, A. Khudaverdian, and Z. Pétrossian (Inst. of Physics, Erivan). Nucl. Phys., 43: 492-9(May 1963). (In French)

The mean life of the 619-kev level in Ta^{181} was measured in two different ways by means of delayed coincidence techniques. The obtained half-life value is: $T_{1/2} = 2.4 \pm 0.5$ ns. This result can be explained by assuming that the 619-kev level is the spin $^3/_2$ member of the $K = {}^1/_2$, [411] rotational band and that the 137 kev γ ray is a K-forbidden M1 transition. (auth)

26533 NUCLEAR REACTIONS OF Ga^{69} AND Ga^{71} WITH 13-56 Mev PROTONS. N. T. Porile (Tokyo Univ. and Brookhaven National Lab., Upton, N. Y.), S. Tanaka, H. Amano, M. Furukawa, S. Iwata, and M. Yagi. Nucl. Phys., 43: 500-22(May 1963). (BNL-6498). (In English)

Excitation functions were measured for a number of (p,xn), (p,pxn), (p,2pxn) and (p,3pxn) reactions of Ga^{69} and Ga^{71} with 13-56 Mev protons. The peak cross sections were determined. The results were compared with statistical theory calculations, cascade-evaporation calculations, and a similar study of the reactions of Zn^{68} + α-particles. It is concluded that the reactions exhibit both compound nuclear and direct interaction features with the latter being consistent with a cascade-evaporation mechanism. Values were obtained for the total reaction cross section of Ga^{69} and they are in agreement with continuum theory values for $r_0 = 1.4$-1.5 fm. (auth)

26534 HALF-LIFE OF THE 1.27 Mev LEVEL IN Sn^{116} BY RESONANT SELF-ABSORPTION. G. B. Beard (Wayne State Univ., Detroit) and W. H. Kelly. Nucl. Phys., 43: 523-7(May 1963). (In English)

Self-absorption measurements of nuclear resonance fluorescence obtained with a gaseous $In^{116m}Cl_3$ gamma source were used to determine the half life of the 1.27 Mev state of Sn^{116}. A value of 0.33 ± 0.07 psec was obtained. (auth)

26535 MEASUREMENTS OF THE TEMPERATURE COEFFICIENT OF RESONANCE ABSORPTION IN URANIUM METAL AND URANIUM OXIDE. B. L. Palowitch and F. S. Frantz, Jr. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 15: 146-57(Feb. 1963).

The relative effective resonance integral of U^{238} was measured as a function of temperature for uranium and UO_2 cylinders, 0.986 and 0.973 cm diam, respectively. The Doppler coefficients α and β are defined by: $RI_t = RI_0[1 + \alpha(t - t_0)]$ and $RI_t = RI_0[1 + \beta(\sqrt{T} - \sqrt{T_0})]$. RI_0 refers to the effective resonance integral (excluding 1/v absorption) at 20°C, and t_0 and T_0 are 20°C and 293°K respectively. The measurements utilized the activation technique in

which the induced Np^{239} activity of a uranium bearing specimen was determined as a function of specimen temperature during irradiation. Measured values for α and β corrected for thermal expansion, 1/v absorption, fission activity and a deviation from a 1/E epithermal flux are for metal $\alpha = 1.14 \pm 0.07 \times 10^{-4}/°C$, $\beta = 0.53 \pm 0.03 \times 10^{-2}/(°K)^{1/2}$ and for oxide $\alpha = 1.34 \pm 0.11 \times 10^{-4}/°C$, $\beta = 0.69 \pm 0.06 \times 10^{-2}/(°K)^{1/2}$. The temperature increments for which these values were obtained were 580 and 950°C for uranium metal and oxide respectively. The results are considered to be consistent with the results of other experiments in which the activation technique was used but are lower than theoretical predictions given by Nordheim and Rosén. (auth)

26536 AVERAGE NUMBER OF PROMPT NEUTRONS EMITTED IN THE SPONTANEOUS FISSION OF U^{238} AND Pu^{240}. I. Asplund-Nilsson, H. Conde, and N. Starfelt (Research Inst. of National Defence, Stockholm). Nucl. Sci. Eng., 15: 213-16(Feb. 1963).

The average number, $\bar{\nu}$, of prompt neutrons emitted in the spontaneous fission of U^{238} and Pu^{240} was measured relative to $\bar{\nu}$ for the spontaneous fission of Cf^{252}. This reference value is taken to be $\bar{\nu} = 3.80$. The measurements were performed with large liquid scintillators and the results obtained are $\bar{\nu}_{sp}$ (U^{238}) = 1.97 ± 0.07 and $\bar{\nu}_{sp}$ (Pu^{240}) = 2.154 ± 0.028. (auth)

26537 AN UPPER LIMIT FOR THE EFFECTIVE CAPTURE CROSS SECTION OF Po^{210} FOR THERMAL NEUTRONS. J. Halperin and J. H. Oliver (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 15: 217(Feb. 1963).

Irradiations of Po^{210} were carried out in the Oak Ridge Research Reactor. No evidence was found in the alpha spectra for the production of Po^{211} isomers, and upper limits were set for the activation cross sections of Po^{210}: < 30 mb for the formation of 0.52-sec Po^{211} and < 0.5 mb for the formation of 25-sec Po^{211}. The low cross sections are attributed to the closed shell of Po^{210}. (D.L.C.)

26538 THE MASS SPECTROMETRIC DETERMINATION OF THE Cs^{137} HALF-LIFE. B. F. Rider, J. P. Peterson, Jr., and C. P. Ruiz (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng., 15: 284-7(Mar. 1963).

The half life of Cs^{137} was measured by observing the rate of growth of stable Ba^{137} from a known quantity of Cs^{137} by the use of isotope dilution mass spectrometry. The half life thus obtained is 29.2 ± 0.3 years. (auth)

26539 CALCULATION OF PARTIAL DIFFERENTIAL SCATTERING CROSS SECTIONS FOR SLOW NEUTRONS. H. L. McMurry (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 15: 429-37(Apr. 1963).

As an approach to developing methods for calculating differential scattering cross sections of materials for neutrons with energy below 1 ev, five approximations to the exact formalism of Zemach and Glauber were applied to treat the scattering by gases composed of semirigid molecules. The theory is outlined for the following methods: (1) A quite rigorous method valid when the neutron energy and k_BT are both much less than the characteristic vibrational energies of the molecules. (2) A method which treats vibrations harmonically, rotations classically, and neglects rotation-vibration coupling. Within these limitations the method is valid at all neutron energies. (3) A method like (2) except that averages over orientation are approximated by the Krieger-Nelkin method of introducing average values of functions of the Eulerian angles wherever they appear. (4) A method which treats vibrations with characteristic energies much less than the neutron energy by a short collision time approximation. (5) A method which treats such low energy vibrations classically. Method (5) has the feature that when all normal modes are treated classically the equation for the differential scattering cross section reduces to that for scattering by unbound particles. If some, but not all, vibrations are treated classically and averages over orientation are approximated as in method (3) the effective mass for a scattering atom attached to the molecule is intermediate between the mass of the atom and the Sachs-Teller mass which applies when all vibrations are treated exactly by quantum mechanics. Method (5) has the advantage of being easily adapted to treating simple models for liquids and amorphous solids. (auth)

26540 EVALUATION OF TECHNIQUES FOR COMPUTING PARTIAL DIFFERENTIAL SCATTERING CROSS SECTIONS. H. L. McMurry, L. J. Gannon, and W. A. Hestir (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 15: 438-50(Apr. 1963).

The methods presented in the accompanying paper for computing partial differential scattering cross sections are evaluated by comparing calculated results with experimental results for methane and propane, and by comparing results on a hypothetical OH molecule of the more approximate methods with the most rigorous ones. The method which treats rotations quantum mechanically gives good agreement with experiments on methane and can be considered as rigorous. The method which treats rotations classically, vibrations by quantum mechanics, and averages over orientation exactly also agrees well with methane experiments, except for scattering at forward angles and low neutron energies where the energy exchanges are comparable to the rotational level spacings. It is used as a standard of comparison for calculations on the OH molecule. The Krieger-Nelkin method (K.N.), which also treats rotations classically but averages over orientation by inserting average values of functions of the Eulerian angles wherever they appear, works very well at low neutron energies. Calculations on OH show that when the characteristic vibrational energy is high, but much lower than the incident neutron energy, the K.N. averaging breaks down. The short collision time method of treating low energy vibrations is impractical because too many terms in the required series expansion are needed to give good results. The method which treats low energy vibrations classically is very promising. It gives very good results when the characteristic vibrational energies are low, and is better than the K.N. when the characteristic energy is high, but much lower than the neutron energy. It is indicated how the third and fifth methods can be used to treat liquids and solids when the atomic motions can be described by simple dynamical models. (auth)

26541 AN ABSOLUTE MEASUREMENT OF $\underline{\nu}$ OF Cf^{252}. I. Asplund-Nilsson, H. Condé, and N. Starfelt (Research Inst. of National Defense, Stockholm). Nucl. Sci. Eng., 16: 124-30(May 1963).

An absolute determination of the average number of neutrons, $\underline{\nu}$, emitted in the spontaneous fission of Cf^{252} was made by counting the fission neutrons in a large liquid scintillator. The detection efficiency of this counter was measured as a function of neutron energy. Well-collimated neutrons were scattered into the scintillator by an anthracene crystal, which detected the corresponding recoil protons. Pulse-shape discrimination was employed to eliminate γ-ray background. The average number of prompt

neutrons emitted per Cf^{252} fission was found to be 3.799 ± 0.034. (auth)

26542 ELASTIC SCATTERING OF NEUTRONS BY ^4He, ^{12}C AND ^{16}O NUCLEI. PHASE SHIFT ANALYSIS. G. Pisent (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua) and A. M. Saruis. Nuovo Cimento (10), 28: 600-13(May 1, 1963). (In English)

The elastic scattering of neutrons by He^4, C^{12}, and O^{16} nuclei was investigated at low energies. The phase-shift behavior was derived from analyses of the differential cross-sections. The level parameters were obtained by application of dispersion formalism to the extracted phase shifts. The polarization calculated from phase shifts shows in general a satisfactory agreement with experiment. (auth)

26543 THE ENERGY SPECTRUM OF NEUTRONS FROM STOPPED π^- INTERACTIONS IN EMULSIONS. A. G. Barkow (Marquette Univ., Milwaukee), C. E. Edmund, F. E. Penaranda, G. Kane, and Z. O'Friel. Nuovo Cimento (10), 28: 673-84(May 16, 1963). (In English)

The energy distribution of neutrons originating in the capture of stopped meson (π^-) interactions in nuclear emulsion was determined. The neutron spectrum was obtained by observing the energy distribution of some 10,000 knock-on protons. By differentiating the knock-on proton spectrum one can obtain the neutron spectrum. The results indicate that the neutrons produced in π^- interactions have a Maxwellian distribution with a most probable energy near 5 Mev. To check the results obtained above, the procedure was reversed. It was assumed that the neutron spectrum follows statistical theory and that the peak of the distribution appears at E = T = 5 Mev. By integrating the equation for the neutron spectrum one obtains a theoretical curve for the knock-on proton spectrum. The results indicate that there is excellent agreement between the experimentally obtained knock-on proton spectrum and the calculated proton spectrum. It can be concluded that the neutrons emitted in π^- interactions follow statistical theory and have an average nuclear temperature of 5 Mev. (auth)

26544 STUDY OF THE CROSS-SECTION OF A DIRECT NUCLEAR REACTION IN THE VICINITY OF ITS SINGULARITIES. J. Ruelle-Lardinois (Université Libre, Brussels). Nuovo Cimento (10), 28: 724-35(May 16, 1963). (In English)

The simplest graphs corresponding to direct nuclear reactions are studied. The position of the singularities of simply connected graphs with no more than 2 incoming and outgoing particles at each vertex was determined. The residue at these poles was calculated and related to the level width or to the relative weight of cluster configurations of the interacting nuclei. The calculations were made in the general case of two incoming particles and of two or three outgoing particles with spins different from zero. (auth)

26545 NUCLEAR LEVEL DENSITY FOR AN INTERACTING FERMI SYSTEM. V. Canuto (Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 28: 742-51 (May 16, 1963). (In English)

The calculation of the nuclear level density when the nucleus is considered as a statistical assembly of nucleons with a two-body residual interaction is presented. The level density, which is normally given for a nucleus without residual interaction, thus results generalized. (auth)

26546 THE KNOCK-ON ELECTRONS OF FAST μ-MESONS. S. P. Viswanathan, R. Mace, and E. D. Palmatier (Univ. of North Carolina, Chapel Hill). Nuovo Cimento (10), 28: 850-7(May 16, 1963). (In English)

An experiment to determine the dependence of knock-on production upon the thickness and type of material is discussed and a summary of a literature survey dealing with other aspects of this problem is presented. (auth)

26547 MEASUREMENT OF THE (n,2n) EFFECTIVE CROSS SECTION OF Ag^{109} AND Ag^{107} FOR 14-Mev NEUTRONS. Herbert Vonach. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 9, 116-21(June 22, 1961). (In German)

The effective cross sections of Ag^{109} and Ag^{107} for 14-Mev neutrons were determined by activation of natural silver and absolute measurements of the originating activities. The neutron reactions (n,2n) with Ag^{107} yielded two isomers (24 min and 8.3 days) and with Ag^{109} yielded Ag^{108} with a half life of 2.4 min. Values obtained for cross sections were 0.84 ± 0.15 b for $Ag^{109}(n,2n)Ag^{108}$, 0.74 ± 0.12 b for $Ag^{107}(n,2n)Ag^{106}$ (24 min), and 0.60 ± 0.10 b for $Ag^{107}(n,2n)Ag^{106}$(8.4 days). (M.C.G.)

26548 REPORT ON THE DECAY SCHEME OF POTASSIUM-44. Peter Hille. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 12, 195-200(Nov. 9, 1961). (In German)

K^{44} was prepared by (n,p) reactions with Ca^{44}. The half life of K^{44} was measured to be 22.0 ± 0.3 min. The gamma spectrum above 1.7 Mev was followed for longer than 5 half lives. From a Curie diagram of the β spectra of K^{44}, the maximum energy of the high-energy component was 5.25 ± 0.2 Mev. A decay scheme is presented. (M.C.G.)

26549 DETERMINATION OF EFFECTIVE CROSS SECTIONS OF CALCIUM ISOTOPES FOR 14.9-Mev NEUTRONS BY THE ACTIVATION METHOD. Peter Hille. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 12, 200-3(Nov. 9, 1961). (In German)

For determination of the cross sections for $Ca^{42}(n,p)K^{42}$, $Ca^{44}(n,p)K^{44}$, $Ca^{44}(n,\alpha)Ar^{41}$, and $Ca^{48}(n,2n)Ca^{47}$. A calcite crystal was irradiated with 14.9-Mev neutrons. The absolute activity of the nuclides originating from the calcium isotopes was determined by measurement of their gamma spectra. The energies of the gamma lines, their frequency per decay and the half life of the nuclides are given. The following results were obtained for cross sections: 140 ± 45 mb for $Ca^{42}(n,p)$, 25 ± 12 mb for $Ca^{44}(n,p)$, 35 ± 10 mb for $Ca^{44}(n,\alpha)$, and 1070 ± 360 mb for $Ca^{48}(n,2n)$. (M.C.G.)

26550 ENERGY AND ANGULAR DISTRIBUTION OF α RADIATION FROM THE REACTIONS $Al^{27}(n,\alpha)Na^{24}$ AND $Co^{59}(n,\alpha)Mn^{56}$ WITH 14-Mev NEUTRONS. W. Patzak and H. Vonach. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 12, 203-9(Nov. 9, 1961). (In German)

The (n,α) reaction on Co^{59} and Al^{27} was investigated in order to determine the energy and angular distribution of the alpha particles. Neutrons with an energy of 14 Mev were used. The energy distribution of the alpha particles was found to depend on the layer density of the rest nucleus. Results are presented in graphs. (M.C.G.)

26551 DETERMINATION OF THE EFFECTIVE CROSS SECTIONS FOR THE (n,2n) REACTION ON Mn^{55}, Co^{59}, Cr^{52}, Fe^{56}, AND Zn^{68} FOR 14-Mev NEUTRONS. R. Wenusch and H. Vonach. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 1, 1-7(Jan. 11, 1962). (In German)

The effective cross sections were determined either by activation of the natural element or the isotope selected with 14-Mev neutrons and absolute measurements were made of the γ or K-x radiation of the nucleides originating from the (n,2n) reaction. Cross sections were determined

for (n,2n) reactions with Cr^{52}, Mn^{55}, Fe^{56}, Co^{59}, and Zn^{66} to be 0.28 ± 0.06, 0.60 ± 0.12, 0.44 ± 0.09, 0.63 ± 0.12, and 0.53 ± 0.10 b, respectively. (M.C.G.)

26552 THE β-BRANCH FROM Tl^{207} TO THE $p_{\frac{1}{2}}$-LEVEL IN Pb^{207}. P. R. Christensen, O. B. Nielsen, and H. Nordby (Univ. of Copenhagen). Phys. Letters, 4: 318-19(May 15, 1963). (In English)

To establish a β-branch to the 894-kev level in Pb^{207} by measuring the depopulating γ ray, Tl^{207} must be separated radiochemically from Pb^{211}, which emits strong γ rays in the same energy region. Two different radiochemical procedures were employed. From the two independent measurements, a mean value of 0.155 ± 0.020% was obtained, in close agreement with a previous calculation. The corresponding log f_0t is 6.47 ± 0.06. (C.E.S.)

26553 NUCLEAR POLARISATION OF Mn^{54} IN IRON. J. A. Cameron, R. A. G. Lines, B. G. Turrell, and P. J. Wilson (Clarendon Lab., Oxford). Phys. Letters, 4: 323-5 (May 15, 1963). (In English)

The hyperfine field in Mn^{54} dissolved in iron was measured by the method of nuclear orientation. The hyperfine field was found to be 146 ± 5 k oersteds. From this value for the hyperfine field the zero-field nuclear magnetic resonance frequency of stable Mn^{55} in iron was predicted to be 154 Mc. The nuclear contribution to the specific heat of dilute Mn–Fe alloys was discussed and it was suggested that Mn^{54} provides a suitable alternative thermometer for investigations of the nuclear orientation of isotopes having γ rays with energy near the Co^{60} γ ray. (C.E.S.)

26554 HIGH-SPIN RESONANCES IN $C^{12}(C^{12},\alpha)Ne^{20}$. J. A. Kuehner, J. D. Prentice, and E. Almqvist (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Letters, 4: 332-5(May 15, 1963). (In English)

A well-defined and variable energy beam of C^{12} ions was used for high-spin resonance measurements in the $C^{12}(C^{12},\alpha)Ne^{20}$ reaction. Angular distributions of alpha particles leading to the ground state of Ne^{20} at 10.6, 10.75, 11.4, and 12.35 Mev are shown. The total cross section was investigated over a wider range of energies and for the reactions leading to both the ground and first excited state of Ne^{20} using data at only eight angles. (C.E.S.)

26555 EVIDENCE FOR THE MESONIC DECAY OF HEAVY HYPERFRAGMENTS. A. Perlmutter (Israel Atomic Energy Commission, Rehovoth and Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 4: 336-8 (May 15, 1963). (In English)

Two double star events in the reaction of 800 Mev/c mesons(K^-) with emulsion nuclei are described. The connecting tracks are very short, suggesting mass numbers $\gtrsim 60$. The characteristics of the charged particles emitted in the primary interaction stars are listed. The products of the secondary star in both cases include a very slow meson(π), much slower than that expected from decays of corresponding hyperfragments with mass numbers up to 15. (C.E.S.)

26556 CIRCULAR POLARISATION MEASUREMENTS IN THE β DECAY OF Na^{24} AND Al^{24}. E. L. Haase, H. A. Hill, and D. B. Knudsen (Princeton Univ., N. J.). Phys. Letters, 4: 338-40(May 15, 1963). (PUC-1963-103). (In English)

The degree of circular polarization of the γ ray emitted subsequent to the positron decay of Al^{24} and the beta decay of Na^{24} is measured as a test of the conserved vector current theory of β decay. The circular polarization measurements constitute a sensitive way of determining the Fermi matrix elements. A deviation of the difference of the two Fermi matrix elements from zero implies a violation of the conserved vector current theory of β decay. The results are consistent with the theory. (C.E.S.)

26557 PRODUCTION OF HYPERFRAGMENTS FROM THE INTERACTIONS OF 50–300 Mev/c K^- MESONS WITH EMULSION NUCLEI. J. P. Lagnaux (Université Libre, Brussels), J. Lemonne, J. Sacton, L. Bishara, D. H. Davis, and M. A. Hussain. Phys. Letters, 4: 341-3 (May 15, 1963). (In English)

The production of hyperfragments in emulsions by the reaction of mesons(K^-) in an intermediate momentum range of 50–300 Mev/c was investigated. The range distribution of the hyperfragments is given. The hyperfragments in the range grouping of 2–10 μ are attributed to the spallation products of light nuclei whereas those of longer range are mainly light hyperfragments of charge 1 or 2 emitted from both heavy and light nuclei. No mesonic decay was observed for hyperfragments of less than 2 μ range and the non-mesonic to mesonic decay ratio was found to be 6 for the range 2–10 μ and 1.5 for those greater than 10 μ. (C.E.S.)

26558 MEASUREMENT OF THE g-FACTOR OF THE 247 kev STATE IN Cd^{111} WITH THE DIFFERENTIAL METHOD. E. C. O. Bonacalza and G. B. Holm (Nobel Inst. of Physics, Stockholm and Royal Inst. of Tech., Stockholm). Phys. Letters, 4: 343-4(May 15, 1963). (In English)

The gyromagnetic ratio of the 247 kev state in Cd^{111} was measured using the differential method. This was achieved by analyzing coincidences between the 172 and 247-kev γ rays in the decay of In^{111} with a time to pulse height converter. The result for the magnetic moment after correction for diamagnetism is –(0.794 ± 0.0045) nm. (C.E.S.)

26559 ANALYSIS OF THE DATA FOR THE BETA DECAYS $Rb^{86} \rightarrow Sr^{86}$ AND $Rb^{84} \rightarrow Kr^{84}$. J. Eichler and S. Wahlborn (California Inst. of Tech., Pasadena). Phys. Letters, 4: 344-7(May 15, 1963). (In English)

The correlation coefficients, the average shape factor, and relativistic matrix elements for the beta decays $Rb^{86} \rightarrow Sr^{86}$ and $Rb^{84} \rightarrow Kr^{84}$ were calculated. The results were given in terms of the six nuclear parameters. Recent measurements of the angular distribution of circularly polarized γ rays following the forbidden β decays were used. (C.E.S.)

26560 SOME POSSIBLE CONSEQUENCES OF THE EXISTENCE OF THE STATES H^4 AND H^5. P. E. Argan (Università, Naples) and A. Piazzoli. Phys. Letters, 4: 350-1(May 15, 1963). (In English)

Isotopic spin values are proposed for the excited states of H^4 and H^5. The values are non-contradicting. (C.E.S.)

26561 ABSORPTION TIME OF NEGATIVE PIONS IN LIQUID HYDROGEN. E. Bierman, S. Taylor, E. L. Koller, P. Stamer, and T. Huetter (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Letters, 4: 351-3(May 15, 1963). (In English)

Measurements of mesons (π^-) stopping in liquid hydrogen are reported. The mean time for the meson (π^-) to go from v/c = 0.006 to nuclear capture is found to be (2.0 ± 0.6) × 10^{-12} sec. The depth of the decay point, the meson (μ) range, and the decay angle, together with their errors, are calculated. (C.E.S.)

26562 THE REDISCOVERED J = ½ STATE OF Li^7. M. H. Waechter (General Electric Co., San Jose, Calif.). Phys. Letters, 4: 353(May 15, 1963). (In English)

Attention was drawn to a previous experiment on the $Li^7(\gamma,\alpha)H^3$ reaction in which a peak was observed cor-

responding to a Li^7 state at 5.5 Mev and given the assignment of $J = 5/2$. This experiment substantiates predictions of a $J = 5/2$ state for Li^7 from the intermediate coupling shell model and the cluster model. (C.E.S.)

26563 LOW ENERGY LEVELS IN Au^{199}. M. C. Joshi, B. V. Thosar, and K. G. Prasad (Tata Inst. of Fundamental Research, Bombay). Phys. Letters, 4: 354-7(May 15, 1963).

The decay of Pt^{199} was investigated and the low-lying level scheme of Au^{199} was established. Single γ spectra, total absorption γ spectra, and extensive β-γ, γ-β, and γ-γ coincidence measurements were made near a nuclear reactor. The low energy levels of Au^{193}, Au^{195}, and Au^{197} were also reported. (C.E.S.)

26564 ON THE ANGULAR DISTRIBUTION OF NEUTRON POLARIZATION FROM THE $Li^7(p,n)Be^7$ FOR $E_p = 4.5$ Mev. I. Minzatu, A. Calboreanu, N. Martalogu, R. Dumitrescu, and M. Molea (Inst. of Atomic Physics, Bucharest). Phys. Letters, 4: 357-8(May 15, 1963). (In English)

It is concluded that the polarization of the neutrons emitted from the $Li^7(p,n)Be^7$ reaction in the 4.5 Mev range does not occur only by the formation of compound nucleus but also by direct interaction. It could be supposed that the incident proton interacts with only one of the neutrons in the $P_{3/2}$ shell of the nucleus. This reaction bears striking resemblance to the $T(p,n)He^3$ reaction. (C.E.S.)

26565 EFFECT OF NONLOCAL POTENTIAL ON THE BARRIER PENETRABILITY IN ALPHA DECAY. Manujendra Lal Chaudhury (Indian School of Mines, Dhanbad). Phys. Rev., 130: 2339-41(June 15, 1963).

The penetrability factor for alpha emission was calculated from the following standpoint. The barrier for alpha emission is the usual Coulomb field assumed here to be superposed by a nonlocal alpha-nucleus interaction. The static part of the barrier is taken to be the Igo potential and its nonlocal part is assumed to be represented by an approximate delta function. Calculations for the ground-state transitions of all the even-even nuclei were completed. The results show that the current values of penetrability are too low, and that the inclusion of the nonlocal correction factor increases these local values by more than 50%. (auth)

26566 (p,d), (p,t), AND (p,α) REACTIONS TO THE SAME FINAL STATES IN Fe^{56} AND IN Zr^{90}. J. B. Ball, C. B. Fulmer, and C. D. Goodman (Oak Ridge National Lab., Tenn.). Phys. Rev., 130: 2342-8(June 15, 1963).

The reactions $Fe^{57}(p,d)$, $Fe^{58}(p,t)$, and $Co^{59}(p,\alpha)$, all exciting final states in Fe^{56}, and the reactions $Zr^{91}(p,d)$, $Zr^{92}(p,t)$, and $Nb^{93}(p,\alpha)$, all exciting final states in Zr^{90}, were studied with 22-Mev protons from the ORNL 86-in. Cyclotron. The angular distributions and cross sections for each of these reactions exciting the same final states were obtained. The cross sections for exciting a given final state by each of the reactions provides an indication of the relative probability for the single, double, and triple pickup process. (auth)

26567 REMARKS ON THE PRESENT STATUS OF THE PROBLEM OF THE X-RAY DEFICIENCY IN μ-MESONIC ATOMS. Y. Eisenberg (Weizmann Inst. of Science, Rehovoth, Israel) and D. Kessler. Phys. Rev., 130: 2349-51 (June 15, 1963). (IA-807)

The K and L x ray yields from μ-mesonic atoms were recently remeasured. These results show better agreement with the theoretical predictions than previous measurements, but some discrepancy still persists. It is shown that the problem really reduces to a striking incompatibility between the observed high K_α and low L yields in low Z elements (carbon to oxygen). Furthermore one can show, with the help of theoretical and experimental arguments, that the Auger effect cannot make up for this difference. The crucial problem is, therefore: How is the 2p state in carbon and other light elements populated? (auth)

26568 K^--MESONIC ATOMS. Y. Eisenberg (Weizmann Inst. of Science, Rehovoth, Israel) and D. Kessler. Phys. Rev., 130: 2352-60(June 15, 1963). (IA-805)

Computational techniques previously used for the treatment of μ^-- and π^--mesonic atoms are extended to K^--mesonic atoms and x-ray yields for the most important transitions are calculated as a function of atomic number. It is shown that the experimental measurement of these yields will provide a sensitive determination of the imaginary part of the K^--nucleus optical potential. The level shifts due to the meson scattering interaction are also discussed. In principle, one can relate the level shifts to the real part of the zero-energy scattering lengths with the help of the theory of Deser et al.; however, the calculations show that, for the ground state, such measurements will be more difficult to perform than in π^--mesonic atoms because of the low yields of the K lines. Therefore, an attempt was made to predict the shifts of the 2p state. It turns out that these shifts are expected to be measurable, both from the point of view of magnitude and yield, for the elements from carbon to fluorine. The Auger electron spectra from stopping K^- mesons in nuclear emulsion are derived from the cascade calculations. In particular, it is shown that the expected fraction of K^- captures associated with at least one Auger electron of more than 15 kev energy is 4% in the light (C,N,O) and 88% in the heavy (AgBr) emulsion elements. An experiment on Auger electrons in nuclear emulsion is described. Whereas the theoretical and experimental numbers of K^- stoppings associated with electrons are in good agreement, there are systematic discrepancies in the details of the energy and multiplicity spectra that are, most probably, due to experimental uncertainties. The level shifts in π-mesonic atoms are briefly discussed in an Appendix. (auth)

26569 ELECTRON SHAKE-OFF FOLLOWING THE BETA DECAY OF Ne^{23}. Thomas A. Carlson (Oak Ridge National Lab., Tenn.). Phys. Rev., 130: 2361-5(June 15, 1963).

A specially designed mass spectrometer is used to analyze the sodium ions that result from the β^- decay of Ne^{23}. The percent abundances are as follows: Na^{1+} (79.1), Na^{2+} (17.5), Na^{3+} (2.85), Na^{4+} (0.48), Na^{5+} (0.081), Na^{6+} (0.006), Na^{7+} (<0.002). No evidence is found that recoil energy contributes to the electron shake-off. An attempt is made to derive the charge spectrum from the assumption that electron shake-off is due to the sudden, nonadiabatic change in nuclear charge. Multiple electron shake-off is computed from the product of the probabilities for single electron shake-off. The probabilities for single electron shake-off are semiempirically calculated. In general, the calculated values agree well with the experimental data, though the computations underestimate the abundances of the more highly charged ions. (auth)

26570 $B^{11}(d,n)C^{12*}_{4.43}$ (γ-n) ANGULAR CORRELATIONS AT 0.94 AND 0.62 Mev. W. F. Huang and R. C. Ritter (Univ. of Virginia, Charlottesville). Phys. Rev., 130: 2366-72(June 15, 1963).

The (γ-n) angular correlations are reported for the $B^{11}(d,n)C^{12*}_{4.43}$ reaction at incident deuteron energies of 1

and 0.7 Mev. Correlations were measured with the γ detector perpendicular to the reaction plane and with the detector in the reaction plane. The latter were taken with the neutron detector at 0, 10, 45, 90, 135, and 150°. Strong P_4 terms appear in the reaction plane corrections. This suggests either the presence of compound nuclear effects in the reaction, or a more complicated stripping situation than was previously assumed for this reaction. (auth)

26571 COMPARISON OF THE $C^{13}(d,\alpha)B^{11}$ AND $B^{11}(He^3,p)C^{13}$ REACTIONS. B. B. Marsh and O. M. Bilaniuk (Univ. of Rochester, N. Y.). Phys. Rev., 130: 2372-80(June 15, 1963).

Angular distributions were measured for $C^{13}(d,\alpha)B^{11}$ ground state reaction at 3.35, 3.55, 3.85, and 4.20 Mev. Differential excitation functions for this reaction were measured in 100-kev intervals over the 3.1 to 4.2-Mev region at 54, 84, 119, and 154°. Angular distributions for the $B^{11}(He^3,p)C^{13}$ ground state reaction were measured at 8.6, 9.6, and 10.3 Mev. Differential excitation functions were measured in 200-kev intervals over the 8.0 to 11.0-Mev region at 35 and 140°. The two reactions studied are related in that both involve the transfer of a deuteron between B^{11} and C^{13} in a common momentum transfer region. Notwithstanding, the two reactions appear to proceed predominantly by different mechanisms, viz. compound-nucleus formation and direct process, respectively. The $C^{13}(d,\alpha)B^{11}$ data are fitted using Legendre polynomials in $\cos\theta$. The forward portions of angular distributions of $B^{11}(He^3,p)C^{13}$ are fitted using two versions of the plane wave Born approximation theory. (auth)

26572 SYMMETRY OF NEUTRON-INDUCED U^{235} FISSION AT INDIVIDUAL RESONANCES. [PART] II. G. A. Cowan, B. P. Bayhurst, and R. J. Prestwood (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 130: 2380-3(June 15, 1963). (LADC-5636)

Neutrons from the Project Gnome nuclear test were resolved in energy by time-of-flight and used to study symmetry of fission in U^{235} in the resonance region. Symmetry was deduced by measurement of the fission product ratio Ag^{111}/Mo^{99} at resonances from 8.8 to 40 ev. The maximum decrease observed in the probability of symmetric fission as compared to the probability in thermal fission of U^{235} was 50%. The maximum increase observed was 22%. Four levels showed an increase in symmetry. Thirteen levels showed a decrease in symmetry. With the exception of one level at 15.4 ev, assignments of levels by symmetry are in agreement, in the region covered, with previous work. (auth)

26573 EXCITATION FUNCTIONS FOR Tb^{149g} FROM REACTIONS BETWEEN COMPLEX NUCLEI. John M. Alexander and Gabriel N. Simonoff (Univ. of California, Berkeley). Phys. Rev., 130: 2383-7(June 15, 1963). (UCRL-10525)

Excitation functions were measured for twelve reactions that produce 4.1-h Tb^{149g} from Tb compound nuclei. Projectiles were B^{10}, B^{11}, C^{12}, N^{14}, N^{15}, O^{16}, O^{18}, and F^{19}. Peak cross sections range from approximately 0.5% to approximately 7% of the calculated total reaction cross section. The excitation functions are well systematized by the simple assumption that only these compound nuclei of angular momentum less than $7.5 \pm 1.5\hbar$ are effective in these reactions. (auth)

26574 HALF-LIVES OF N^{12} AND B^{12}. Thornton R. Fisher (California Inst. of Tech., Pasadena). Phys. Rev., 130: 2388-90(June 15, 1963).

The half-lives of N^{12} and B^{12} were measured with high precision because of recent interest in the spectrum shape of these two beta emitters. The N^{12} and B^{12} activities were made in the reactions $B^{10}(He^3,n)N^{12}$ and $B^{11}(d,p)B^{12}$ by bombarding boron targets with He^3 ions and deuterons. The beam was obtained from the 3-Mev electrostatic accelerator at the Kellogg Radiation Laboratory, and was pulsed on for 20 msec and off for 180 msec. During the beam-off period, the counts from the N^{12} or B^{12} activity were recorded as a function of time using a 400-channel time interval analyzer. The measured values for the half-lives are $t_{1/2}(N^{12}) = 10.95 \pm 0.05$ msec and $t_{1/2}(B^{12}) = 20.3 \pm 0.1$ msec. Using these values, the ft values for the decays of N^{12} and B^{12} to the ground state of C^{12} are $ft(N^{12}) = (1.33 \pm 0.027) \times 10^4$ and $ft(B^{12}) = (1.17 \pm 0.012) \times 10^4$. The uncertainties quoted for the ft values include the uncertainties in the branching ratios and end-point energies for the two decays. (auth)

26575 ANGULAR DISTRIBUTIONS FROM ELASTIC SCATTERING OF 15-Mev DEUTERONS. R. K. Jolly, E. K. Lin, and B. L. Cohen (Univ. of Pittsburgh). Phys. Rev., 130: 2391-6(June 15, 1963).

Angular distributions of 15-Mev deuterons elastically scattered by 23 elements between Al and Pb are presented. A high-resolution detection system provides complete separation from all inelastically scattered deuterons. In light and medium weight elements, there is a sharp diffraction pattern, but it damps out with increasing mass. In a few cases, there are marked differences between angular distributions from nuclei of nearly equal masses. (auth)

26576 ENHANCED EXCITATION OF T = 0, S = 0 STATES OF THE GROUND-STATE CONFIGURATION IN $C^{12}-C^{12}$ SCATTERING AT 126 Mev. Gerald T. Garvey, Andrew M. Smith, and J. C. Hiebert (Yale Univ., New Haven). Phys. Rev., 130: 2397-2407(June 15, 1963).

A detailed study was made on the scattering of C^{12} from C^{12} at 126 Mev in order to better understand the inelastic scattering mechanisms involved in these reactions. Earlier experiments noted four prominent peaks in the energy spectrum of the scattered particles at forward angles. One of these peaks is due to the elastic scattering and another to the excitation of the first excited state in C^{12}. The two remaining peaks correspond to Q values of -9.0 ± 0.7 and -14.0 ± 1 Mev. Using coincidence techniques it is shown that the principal contribution to the Q = −9 Mev peak over the range of angles studied is due to the excitation of both C^{12} nuclei to their first excited state. An angular distribution for this process is obtained and compared to a Born approximation calculation in which all parameters are determined by previous experiments. The Q = −14 Mev peak is shown to be due to the excitation of an α-particle unstable level in C^{12} at 14.0 ± 0.5 Mev. Measurement of the angular distribution of the α particles that decay from this level to the Be^8 ground state indicates that this level has spin and parity 4+. Thus, the levels most strongly excited in these reactions bear a strong similarity to the level sequence expected for a ground-state rotational band in C^{12}. However, the shell model in L · S coupling also accounts for the observed results as the only states in C^{12} with T = 0 and S = 0 with the $(p)^8$ configuration have L = 0, 2, and 4 with relative predicted energies in agreement with our observations. (auth)

26577 PION CAPTURE IN COMPLEX NUCLEI. Zeev Fraenkel (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 130: 2407-16(June 15, 1963). (BNL-6617)

The effect of the finite lifetime of pion-nucleon reso-

nances (isobars) on intranuclear cascades is considered. The existence of these isobars inside the nucleus must be postulated if the impulse approximation is valid for intranuclear cascades involving pions. These isobars may interact with neighboring nucleons before decaying. One such interaction provides a mechanism for the capture of high-energy pions. Assuming the impulse approximation to be valid for isobar-nucleon interactions, the cross section for the capture of a high-energy pion by two nucleons inside the nucleus is estimated. Since this is a pion-nucleon cross section, an intranuclear cascade calculation must be made before the pion-nucleon capture cross section can be obtained and compared with experiment. However, the same mechanism should also hold in the capture of high-energy pions in deuterium. Here the calculated cross section is in satisfactory agreement with the experiment. (auth)

26578 μ-MESONIC X-RAY ENERGIES AND NUCLEAR RADII FOR FOURTEEN ELEMENTS FROM Z = 12 TO 50. H. L. Anderson (Univ. of Chicago), C. S. Johnson, and E. P. Hincks. Phys. Rev., 130: 2468-80(June 15, 1963).

Precise measurements of μ-mesonic x rays were made using a NaI scintillation crystal spectrometer. The 2p–1s transition energies were determined for fourteen elements ranging from Z = 12 to Z = 50. The 3d–2p transition energies were also measured for seven of these elements. The results were interpreted to give a measure of the radial extent of the nuclear charge based on a Dirac theory of the μ-mesonic atom, correcting for the vacuum polarization but taking other possible perturbing effects to be small. The 2p–1s transition energy depends essentially on the second moment of the charge distribution, somewhat independently of the detail of the shape. It is convenient, therefore, to use the equivalent radius $R_{eq} = (5\langle r^2\rangle/3)^{1/2}$ that refers to a sphere of uniform charge distribution having a mean square radius $\langle r^2\rangle$. Our values of $r_0 = R_{eq}/A^{1/3}$ are within $(1.23 \pm 0.02) \times 10^{-13}$ cm for all nine of our elements between A = 35 and A = 119. There is general, but not detailed agreement with the radii that were deduced from the Stanford electron scattering experiments. (auth)

26579 ANOMALOUS SOLUTIONS TO THE DIRAC AND SCHRÖDINGER EQUATIONS FOR THE COULOMB POTENTIAL. Baxter H. Armstrong (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev., 130: 2506-18(June 15, 1963).

Certain anomalous solutions to the Dirac and relativistic Schrödinger equations for the Coulomb potential, some of which were not investigated before, are analyzed. These are solutions for orbital angular momentum $l = 0$ and $l = 1/2$ in the Schrödinger case and total angular momentum $j = 0$ in the Dirac case that are quadratically integrable for all energies $E < 0$. The purpose is to determine if there exist fundamental reasons for discarding them, or if they describe meaningful physical systems. Reasons are given why they may be discarded for real two-body systems, such as the hydrogen atom. These solutions can only be meaningful for systems that have an exact one-body, pure Coulomb relativistic hamiltonian. They are valid for repulsive as well as attractive potentials. It is suggested that the $l = 0$ relativistic Schrödinger solution be identical as the wave function of a nonrigid charged spherical shell. In addition, it is suggested that a particle fluctuating about its own center of mass in zitterbewegung-type motion may experience a repulsive Coulomb self-potential and have an exact one-particle-type hamiltonian. The charge distributions obtained in this interpretation for two of the solutions have mean radii $\sim e^2/m_0c^2$ and rms radii $\sim\hbar/m_0c$. (auth)

26580 HYPERFINE STRUCTURE IN EUROPIUM METAL. P. H. Barrett and D. A. Shirley (Univ. of California, Berkeley). Phys. Rev., 131: 123-7(July 1, 1963).

Mössbauer resonance experiments were performed on europium metal, using the 21.7-kev gamma ray in Eu^{151}. The Néel point of 87°K was confirmed. Above this temperature a single line was observed and attributed to paramagnetic relaxation. At 4.2°K a six-line spectrum was found. Analysis yielded a spin of $^7/_2$ and a moment of $+2.53 \pm 0.03$ nm for the 21.7 kev excited state, an internal field of 264 ± 8 kgauss, and an isomeric chemical shift of -0.81 ± 0.03 cm/sec, relative to Eu_2O_3. This is consistent with an electronic level $4f^76s^2$, $S^8_{7/2}$ for the europium atom. The effect of nuclear deformation on isomeric chemical shifts is considered, and it is concluded that Eu^{151}, with a moderately deformed ground state, has a less deformed excited state at 21.7 kev. (auth)

26581 EFFECTS OF K-CAPTURE DEALIGNMENT AND IONIC COUPLINGS ON LOW-TEMPERATURE NUCLEAR ALIGNMENT. John D. Rogers, William A. Steyert, and John R. Pellam (California Inst. of Tech., Pasadena). Phys. Rev., 131: 170-3(July 1, 1963).

The angular distributions of γ rays emitted from traces of Co^{58} aligned in single crystals of $(xNi, (1-x)Zn, Co^{58})SiF_6 \cdot 6H_2O$ were studied with various nickel fractions (x) between 0 and 0.19. The nuclear alignment is found to be strongly influenced by the presence of paramagnetic nickel ions in the nickel-bearing crystals. Crystals of 0% nickel show evidence of a small dealignment of the 10^{-11} sec intermediate state that just precedes emission of the 810-kev γ ray. This is due to the highly ionized and optically excited electronic shell that is present after the K capture. (auth)

26582 NUCLEAR SPIN AND MAGNETIC HYPERFINE INTERACTION OF 12-DAY Ge^{71}. W. J. Childs and L. S. Goodman (Argonne National Lab., Ill.). Phys. Rev., 131: 245-50(July 1, 1963).

The hyperfine structure of the P^3 atomic ground state of radioactive Ge^{71} was examined by means of the atomic-beam magnetic-resonance technique. The nuclear spin and magnetic dipole moment are measured to be $^1/_2$ and $+0.65 \pm 0.20$ nm, respectively. The magnetic hyperfine interaction constants $a(P^3_1)$ and $a(P^3_2)$ are found to be $\pm(87.005 \pm 0.003)$ and $\pm(357 \pm 6)$ Mc/sec, respectively. The electronic g factor g_J is determined to be 1.50093 ± 0.00008 for the P^3_1 state and 1.4948 ± 0.0007 for the P^3_2 state. (auth)

26583 NUCLEAR MAGNETIC RESONANCE OF Xe^{129} IN SOLID AND LIQUID XENON. W. M. Yen and R. E. Norberg (Washington Univ., St. Louis). Phys. Rev., 131: 269-75(July 1, 1963).

Self-diffusion coefficients, resonance shifts, and nuclear spin-spin relaxation times are reported for Xe^{129} in solid and liquid xenon. In the solid, the T_2 data indicate $D = (7.3^{+0.4}_{-0.2}) \exp[-(7400 \pm 50/RT]cm^2/sec$. In the liquid, direct external gradient-diffusion measurements yield $D = (2.3^{+0.8}_{-0.7}) \times 10^{-3} \exp \times [-(1400 \pm 150)/RT]cm^2/sec$. Density-dependent resonance shifts are found to occur in both the liquid and the solid. (auth)

26584 NUCLEAR MAGNETIC RELAXATION BY INTERMOLECULAR DIPOLE-DIPOLE INTERACTIONS. Paul S. Hubbard (Univ. of North Carolina, Chapel Hill). Phys. Rev., 131: 275-82(July 1, 1963).

The contribution of intermolecular dipole-dipole interactions to the nuclear magnetic relaxation of identical spin-$^1/_2$ nuclei at equivalent positions in spherical molecules in a liquid is calculated. The assumptions made are

that: the effect of cross correlations of different dipole-dipole interactions is negligible, so that the relaxations of the longitudinal and transverse components of the nuclear magnetization are simple exponential decays with relaxation times T_1 and T_2, respectively; the motions of the molecules can be considered to be translational and rotational diffusion; and the correlation time $\tau_0 \equiv (2a^2/D)$, where a is the radius of a molecule and D is the translational diffusion coefficient, is sufficiently short that $(\omega_0\tau_0)^2 \ll 1$, where ω_0 is the Larmor frequency of the nuclei. As a result of the short correlation time assumption (3), the contributions of the intermolecular interactions to $(1/T_1)$ and $(1/T_2)$ are found to be the same and are given by an infinite series. The first term in the series is the result obtained in previous calculations in which the effect of the rotations of the molecules was neglected. (auth)

26585 EMISSION OF PROMPT NEUTRONS IN THE THERMAL NEUTRON FISSION OF U^{235}. S. S. Kapoor, R. Ramanna, and P. N. Rama Rao (Atomic Energy Establishment, Trombay, India). Phys. Rev., 131: 283-96 (July 1, 1963).

The energy distributions of the prompt neutrons emitted along the direction of motion of the light and heavy fragments were measured in the laboratory system by the time-of-flight method. A gridded ionization chamber is used to measure the kinetic energies of the fission fragments and their directions of motion with the electric field direction of the ion chamber. A photomultiplier associated with the chamber detects the scintillations in the gas by the passage of a fragment and gives the zero-time pulse. A fast neutron detector placed along the electric field direction of the ion chamber determines the time-of-flight of the prompt neutrons in coincidence with the selected fission events. From the energy distributions in the laboratory system, the emission spectra of the prompt neutrons from the selected light and heavy fragments were obtained. It is found that for the selected region, the light fragments emit about 30% more neutrons than the heavy fragments and also the average emission energy from the light fragments is about 32% more than that from the heavy fragments. The average nuclear temperatures of the fragments determined from the emission spectra are consistent with the average excitation energies expected from the number of neutrons and gamma rays emitted from the fragments. It is established that the emission spectrum from each fragment is a superposition of the various evaporation spectra corresponding to a distribution of nuclear temperatures. A linear distribution of temperatures up to a certain maximum temperature is found to fit the observed emission spectra. The angular correlations of the prompt neutrons of four different average energies and the light fission fragments were also determined experimentally. The analysis shows that about 10% of the prompt neutrons are not emitted from the moving fragments. These prescission neutrons have an evaporation-like spectrum and an average energy of about 3.2 Mev. It is proposed that these neutrons are evaporated from the excited fissioning nucleus at stages between the saddle point and the scission. (auth)

26586 STUDY OF THE RADIATIONS EMITTED IN THE DECAY OF Ni^{65}. J. E. Cline and R. L. Heath (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev., 131: 296-300 (July 1, 1963).

Radiations emitted in the decay of Ni^{65} were studied using scintillation spectrometry and absolute beta counting. The half-life of this nuclide was measured to be 2.553 ± 0.008 h. A decay scheme is presented that contains some weak transitions observed to depopulate the higher energy states. Intensities are presented for these transitions and upper limits are placed on intensities of previously reported transitions that were not observed. (auth)

26587 DECAY OF Sm^{156}. Ray Gunnink (U. S. Rubber Co., Plainsboro, N. J.). Phys. Rev., 131: 301-4 (July 1, 1963).

The radiations following the decay of 9.4 ± 0.2 h Sm^{156} were studied using techniques of scintillation spectrometry and 4π beta counting. The isotope was produced by fissioning natural uranium in a high neutron flux and except for Sm^{153}, was separated from other fission products by radiochemical techniques. The following gamma-ray energies were observed in the decay of Sm^{156}: 38, x rays (~20%), 87 (40%), 165 (18%), 203 (29%), 252 (5%), and 290 kev (3%). The 87-kev gamma transition was found to be coincident with both the 165 and 203-kev gamma transitions. Its K-shell conversion coefficient is 0.35 ± 0.02. Angular correlation studies indicated the 87–203 kev gamma anisotropy to be about −0.25 and the 87–165 kev gamma anisotropy to be $0 < A < 0.1$. Fermi plots of the beta spectra coincident with the 165 and 203-kev gamma rays produced identical end points of 430 ± 10 kev. Another beta group, 45% in abundance, had an end point of 715 ± 15 kev and presumably goes to the ground state of Eu^{156}. (auth)

26588 DISTORTED-WAVE CALCULATIONS OF LIGHT NUCLEI (d,p) ANGULAR DISTRIBUTIONS. William R. Smith and Eugene V. Ivash (Univ. of Texas, Austin). Phys. Rev., 131: 304-17 (July 1, 1963).

Deuteron stripping angular distributions were calculated for 14 light-target reactions ($A \leq 48$) over a range of bombarding energies, using the distorted-wave Born approximation with diffuse-well optical-model nuclear potentials. A fair degree of agreement with experiment was obtained, though in many cases the results, which depend strongly on the particular reaction considered, are inferior. In some of the latter instances the data are not well fitted; in others the agreement between elastic scattering and stripping parameters, or between parameters for stripping leading to different residual levels of the same final nucleus, is poor. For reactions with $L_N = 0$ it appears that the angular distributions can be reasonably fitted in the neighborhood of the Coulomb barrier as the bombarding energy is raised only if the deuteron real potential depth is appreciably increased. (auth)

26589 ZERO-SPIN ASSIGNMENT FOR THE 2.05-Mev STATE OF Ni^{62} FROM A (p,p'γ-γ) ANGULAR CORRELATION MEASUREMENT. A. K. Sen Gupta and D. M. van Patter (Franklin Inst., Swarthmore, Penna.). Phys. Rev., 131: 318-21 (July 1, 1963).

The γ-γ angular correlation of the 0.88–1.17-Mev cascade, following excitation of the 2.05-Mev state of Ni^{62} by the (p,p') reaction, was measured for angular separations of 90 to 180° at an average bombarding energy of 4.71 Mev. Convincing agreement was found with the correlation expected for a 0(Q)2(Q)0 cascade, thereby providing a unique zero-spin assignment for the second level of Ni^{62}. This assignment accounts for the measured isotropy of the 0.88-Mev cascade transition with respect to the incident beam, as well as the lack of an observed ground-state transition. While a 2+ spin would be expected for the second level according to level systematics for neighboring even-even nuclei, a spin of zero can be accommodated by the recent theoretical predictions of Kerman and Shakin. Other evidence relating to the spin assignments and possible two-phonon character of the well-separated triplet of states in

Ni^{62} is discussed. It is concluded that the measurement of a 0(Q)2(Q)0 γ-γ angular correlation following (p,p') excitation provides a promising method for the unique identification of zero-spin states in medium-weight even-even nuclei. (auth)

26590 PARITY OF THE 5.83-Mev STATE OF N^{14}. J. A. Becker (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 131: 322-4(July 1, 1963). (BNL-6731)

The lifetime of the J = 3, 5.83-Mev level of N^{14} was examined with pulsed beam and coincidence techniques. The 5.83-Mev state was populated by means of the $C^{12}(He^3,p)N^{14}$ reaction. The mean life obtained for the 0.73, 5.83 → 5.10 Mev transition is ≤ 0.3 nsec. This limit for the mean life, together with the polarization measurement of Rose et al., establishes the relative parity of the 5.83- and 5.10-Mev levels to be the same. Since the 5.10-Mev level was established as 2- by Warburton et al., the parity of the 5.83-Mev level is −. (auth)

26591 BETA DECAY OF Fe^{59}. D. E. Wortman and L. M. Langer (Indiana Univ., Bloomington). Phys. Rev., 131: 325-30(July 1, 1963).

The decay of Fe^{59} was studied with particular interest in the shape of the beta spectrum and in the comparative half-life of the very weak, highest energy beta group. This group was found to result from 0.30% of the decays and to have an end-point energy of 1.573 ± 0.003 Mev. The experimental data could be fitted with a shape factor $p^2 + 3.3\ q^2$, consistent in form with that expected for a twice-forbidden $\Delta I = 2$ transition. The comparative half-life is relatively short. The two more intense beta transitions are 0.475 ± 0.003 Mev, 51.2%, logft = 6.74 and 0.273 ± 0.005 Mev, 48.5%, logft = 5.92. The energies of the two high-energy gamma transitions, determined from their K internal conversion lines, are 1.101 ± 0.003 and 1.300 ± 0.003 Mev. (auth)

26592 $O^{16}(d,n)F^{17}$ AND $Ca^{40}(d,n)Sc^{41}$ REACTIONS BY TIME OF FLIGHT. G. F. Knoll, J. S. King, and W. C. Parkinson (Univ. of Michigan, Ann Arbor). Phys. Rev., 131: 331-6(July 1, 1963).

A modified time-of-flight spectrometer was used to check and correct results previously reported for the $O^{16}(d,n)F^{17}$ reaction and to determine the Q values of four low-lying states in Sc^{41} by means of the $Ca^{40}(d,n)Sc^{41}$ reaction. The overlap method of measuring the energies of neutrons is described. (auth)

26593 EVIDENCE FOR "ALPHA-PARTICLE" CLUSTERS IN SEVERAL NUCLEI FROM THE $(\alpha,2\alpha)$ REACTION AT 0.91 Bev. G. Igo, L. F. Hansen, and T. J. Gooding (Univ. of California, Berkeley). Phys. Rev., 131: 337-51(July 1, 1963). (UCRL-10574)

The alpha-particle cluster density was investigated in the region, $\rho < (1/20)\rho_0$, utilizing the $(\alpha,2\alpha)$ reaction at 0.915 Bev. The results are consistent with complete clustering of all nucleons in the density region $\rho < (1/20)\rho_0$. In this region nucleons are less affected by the Pauli principle. When nucleons emerge from the inner region ($\rho = \rho_0$) they give the nucleus extra stability by clustering to form alpha-particle satellites. These structures may have a short lifetime and be constantly forming and redissolving. The alpha-particle nonelastic mean free path in nuclear matter of density $(1/20)\rho_0$ is very short and almost independent of energy as determined from elastic scattering and total-reaction cross section measurements for alpha particles. As a consequence the reaction volume in heavy nuclei is known to be that part of the pole caps where $\rho < (1/20)\rho_0$, and the $(\alpha,2\alpha)$ reaction is very specifically probing this layer. Coincident events were observed from a series of heavy target elements in which two emergent alpha particles were identified in which the sum of their energies was equal to 0.915 Bev. The energy of the individual alpha particles and the angular correlation between them were found to correspond to the free, two-body collision kinematics for equal mass particles. The numbers of such events were consistent with complete clustering of all nucleons in the density region $\rho < (1/20)\rho_0$. (auth)

26594 THE ENERGY LEVELS OF Pd^{106} POPULATED IN THE DECAYS OF Ag^{106} AND Rh^{106}. W. G. Smith (Purdue Univ., Lafayette, Ind.). Phys. Rev., 131: 351-4 (July 1, 1963).

The conversion electrons of 5 high-energy transitions in the decay of Ag^{106} were observed in a permanent magnet spectrograph. The following transitions (in Mev) were observed: the relative intensities of the K-conversion electron lines are given in parentheses: 1.0461(40), 1.1298(19), 1.2010(15), 1.2237(5), and 1.5285(12). These transitions can be fitted into a Pd^{106} level scheme, with slight modifications, proposed by Smith. This scheme was based on gamma-ray and low-energy conversion electron studies. The modified Pd^{106} level diagram is compared with the predictions of several nuclear models. (auth)

26595 "CLASSICAL" SELF-CONSISTENT NUCLEAR MODEL. [PART] II. R. G. Seyler (Ohio State Univ., Columbus) and C. H. Blanchard. Phys. Rev., 131: 355-65 (July 1, 1963).

The gross energetics and sizes of the stable nuclei are accurately reproduced by a simple model of nuclear structure using Thomas-Fermi approximation. Saturation is obtained by taking the two-body interaction to be momentum-dependent. Coulomb effects and neutron-proton mass difference are included. The two coupled nonlinear integral equations for neutron and proton spatial distributions are integrated. The system of equations is made unique by the choice of only four input parameters, and these parameters are optimized by requiring a best fit of the solution to the binding-energy-per-nucleon and neutron-proton-ratio curves as a function of A. The optimum parameter values are reasonable. The Yukawa force range is found to be about 40% of $\hbar/(m_\pi c)$. A small but definite excess of neutron radius over proton radius is found, and also a slight depression of the central proton density for the heavier nuclei. Satisfactory agreement with measured radii and surface thicknesses is obtained. (auth)

26596 ASYMMETRIC CORE COLLECTIVE MODEL FOR ODD-A NUCLEI WITH APPLICATIONS TO THE 2s-1d SHELL. B. E. Chi and J. P. Davidson (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 131: 366-78 (July 1, 1963).

A model for odd-A nuclei is described in which the nucleon is coupled to a possible asymmetric, rotating core. The hamiltonian consists of two parts: H_R, the hamiltonian for a rotating core of fixed shape with quadrupole moments of inertia and H_p, the hamiltonian for the single particle moving in an asymmetric oscillator potential with $1\cdot s$ and 1^2 terms. The energy eigenvalues were obtained by an exact diagonalization of this hamiltonian using an appropriate core-particle basis. To account for the filling of a shell, a basis truncation procedure was developed based, in general, upon the well-known Nilsson single-particle levels. The model was applied to the 2s-1d shell and assignments of the three model parameters were made to all odd-A nuclei in the shell having at least three levels

with known spin and positive parity. The state functions so obtained were used to calculate the static moments and reduced matrix elements of various electromagnetic transitions. This survey shows that these nuclei are generally quite well represented by the model with the result that γ is either zero for $A < 25$ or about 30°, representing maximum asymmetry for $A \geq 25$. The truncations and eigenvalues for each nucleus fitted are appended. (auth)

26597 N^{13} AND C^{11} RANGE AND ANGULAR DISTRIBUTIONS FROM N^{14} ON B^{10}. K. S. Toth (Oak Ridge National Lab., Tenn.). Phys. Rev., 131: 379-83(July 1, 1963).

The range and angular distributions of N^{13} and C^{11} particles resulting from the transfer reactions $B^{10}(N^{14},N^{13})B^{11}$ and $B^{10}(N^{14},C^{13})C^{11}$, respectively, are reported. It is found that in the first reaction N^{13} nuclei originating from transfers to B^{11} excited states are observed at angles larger than angles at which N^{13} particles due to ground-state transfers are observed; also, the peaks of the N^{13} angular distributions shift to larger angles when the bombarding energy is lowered. The investigation of the proton-transfer reaction is limited by the low-kinetic energy of the C^{11} particles at large laboratory angles, where most of them are observed for a bombarding energy of 28.0 Mev. When the incident N^{14} energy is lowered, more C^{11} particles are observed at smaller angles. This variation with bombarding energy is as expected for a recoil particle in a transfer reaction. Experimental results obtained for both reactions are compared with the tunneling mechanism proposed by Breit for nucleon transfer. (auth)

26598 DECAY OF Cd^{115m}. R. P. Sharma and H. G. Devare (Tata Inst. of Fundamental Research, Bombay, India). Phys. Rev., 131: 384-9(July 1, 1963).

The decay of Cd^{115m} was investigated with scintillation and magnetic spectrometers along with the coincidence technique. Gamma rays of 485, 930, 1125, 1285, and 1430-kev energy were observed and their intensities were calculated from the analysis of the gamma spectrum. Weak-intensity gamma rays of energies 160, 310, 650, and 890 kev were observed in the coincidence spectra. The shape of the beta transition to the ground state deviates from the statistical shape and the correction factor for this is calculated. The beta spectrum in coincidence with 930-kev gamma ray was shown to have a unique first-forbidden shape. A decay scheme consistent with these results is presented. (auth)

26599 STRUCTURE OF THE He^3 NUCLEUS. H. Collard and R. Hofstadter (Stanford Univ., Calif.). Phys. Rev., 131: 416-23(July 1, 1963).

The He^3 nucleus was investigated by means of the elastic electron scattering technique. Experiments were carried out in the energy range 110-650 Mev. Absolute differential cross sections were measured at angles lying between 40 and 135° in the above energy range. Form factors were observed for both the charge density and magnetic moment density of the He^3 nucleus. The results indicate that the charge cloud may be represented best by a model similar to a hollow exponential I type of rms radius 2.05 F. The magnetic moment cloud can be represented approximately by a Gaussian model of rms radius 1.66 F. There appears to be a difference between the gross features of the charge and magnetic moment clouds, and the magnetic moment cloud appears to be the more compact of the two. (auth)

26600 3.86-Mev LEVEL IN F^{17}. R. E. Segel, P. P. Singh, R. G. Allas, and S. S. Hanna (Argonne National Lab., Ill.). Phys. Rev. Letters, 10: 345-7(Apr. 15, 1963).

Analysis of data on the radiative capture $O^{16}(p,\gamma)F^{17}$ shows the 3.86-Mev state in F^{17} to have $J^\pi = 5/2^-$ with very small radiation and particle widths. Angular distributions, pulse-height spectra, and differential yields for the reaction were determined by bombarding Ta_2O_5 with a 10-μamp proton beam. The lowest $f_{5/2}$ level also now appears to lie at 5.7 Mev in O^{17} and F^{17}. (D.C.W.)

26601 BETA-DECAY ASYMMETRY AND NUCLEAR MAGNETIC MOMENT OF NEON-19. Eugene D. Commins and David A. Dobson (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 347-51(Apr. 15, 1963).

The asymmetry parameter and the nuclear magnetic moment of Ne^{19} were determined to be -0.057 ± 0.005 and -1.886 ± 0.001 nm, respectively, by observing the reversal of beta-decay asymmetry that occurs when polarized Ne^{19} nuclei undergo resonance reorientation. The procedure and assumptions used are discussed. (D.C.W.)

26602 SPIN TEMPERATURE IN NUCLEAR DOUBLE RESONANCE. F. M. Lurie and C. P. Slichter (Univ. of Illinois, Urbana). Phys. Rev. Letters, 10: 403-5(May 1, 1963). (TID-18623)

A nuclear double resonance technique is used to obtain the spin temperatures of Li^6 and Li^7 in a lithium powder. The method permits simultaneous measurements. (C.E.S.)

26603 ON THE DECAY OF ^{70}As. P. Born, C. Bobeldijk, W. A. Oost, and J. Blok (Vrije Universiteit, Amsterdam). Physica, 29: 277-85(Apr. 1963). (In English)

The beta and gamma radiation following the decay of As^{70} is investigated with a double-focusing beta spectrometer and scintillation techniques. Various gamma rays are observed, and coincidence relations are established between some of them. A tentative decay scheme of As^{70} is proposed, with levels at 1.04, 1.21, 1.71, 2.16, 2.31, 3.07, 3.13, 3.70, 4.10, 4.40, 4.70, and 5.00 Mev. (auth)

26604 PROPOSAL FOR AN IMPROVED METHOD TO DETERMINE THE SPIN OF LOW ENERGY NEUTRON RESONANCES. K. Abrahams (Institutt for Atomenergi, Kjeller, Norway). Physica, 29: 331-4(Apr. 1963).

For a nuclide having a low-energy neutron resonance, built in a ferro- or ferrimagnetic single crystal, the energy dependence of the cross section for nuclear scattering of neutrons can be found by determining the energy dependence of the ratio of the nuclear and magnetic scattering cross sections. This is possible because the magnetic scattering cross section is independent of the energy of the neutrons if a Bragg reflection from a fixed crystal plane is used. The energy dependence of the nuclear cross section can be used to determine the spin of the resonance. (auth)

26605 THE (n,α) REACTION IN ^{27}Al AT 15 Mev USING A COUNTER TELESCOPE TECHNIQUE. M. Irfan and W. Jack (Univ. of Glasgow). Proc. Phys. Soc. (London), 81: 800-7(May 1, 1963).

A proportional-counter scintillation-counter telescope technique was developed to measure the energy distribution and angular distribution of alpha particles emitted from a thin (1.56 mg cm^{-2}) target of Al^{27} bombarded with neutrons of 14.8 Mev from the (D,T) reaction. The energy distribution was obtained with good statistics by minimizing the neutron source–Al^{27} target distance, the alpha particles detected being those emitted in the forward hemisphere at a weighted mean angle of 55° with respect to the direction of the incident neutrons. A modified telescope geometry with improved angular definition (±10°) was used in the measurement of the energy distributions at 5° and 90°

(c.m.) and the differential cross sections at 5°, 38°, 90°, 130° and 139° (c.m.). The energy distributions at different angles are very similar, with the characteristic shape of an evaporation process. Conventional analysis of the statistically good 55° spectrum gave 'nuclear temperatures' of 1.35 and 1.40 Mev, corresponding to two different sets of σ_c (the cross section for the inverse reaction) based on the continuum (r_0 = 1.5 fermi) and optical models respectively. The angular distribution, strongly peaked in the forward direction, is in agreement with that obtained by Kumabe who used the photographic emulsion technique. (auth)

26606 THE ENERGY DISTRIBUTIONS OF ALPHA PARTICLES EMITTED FROM ^{54}Fe, ^{63}Cu, ^{64}Zn, AND ^{107}Ag BOMBARDED WITH NEUTRONS OF 15 Mev. M. Irfan and W. Jack (Univ. of Glasgow). Proc. Phys. Soc. (London), 81: 808-15(May 1, 1963).

A proportional-counter scintillation-counter telescope was used to measure the energy distributions of alpha particles emitted from thin (~1.8 mg cm^{-2}) separated isotope targets of Fe^{54}, Cu^{63}, Zn^{64}, and Ag^{107} bombarded with neutrons of 14.8 Mev from the (D,T) reaction. The alpha particles detected were emitted over a wide angular interval (0°–110°), the weighted mean angle of emission being 55° with respect to the direction of the incident neutrons. The energy spectra were analysed conventionally in terms of the statistical theory of nuclear reactions, and values of 'nuclear temperature' T, level density parameter a and differential cross sections for the (n,α) and (n,nα) reactions are obtained. The differential cross sections are in agreement with those obtained by other methods, and are larger than those usually predicted from the statistical theory. The values of T ~ 1 Mev and a ~ 5 Mev^{-1} obtained for the residual nuclei Cr^{51}, Co^{60} and Ni^{61} are in agreement with comparable data; for Rh^{104} T = 1.2 Mev is obtained. The differential cross sections at 55° in millib/sr for the (n,α) and (n,nα) reactions in target nuclei Fe^{54}, Cu^{63}, Zn^{64} are, respectively, Fe^{54} 6.47 ± 0.65, 0.43 ± 0.1; Cu^{63} 5.65 ± 0.55, 0.65 ± 0.15; Zn^{64} 4.62 ± 0.45, 6.28 ± 1.0; for Ag^{107}(n,α)Rh^{104} the relevant differential cross section is 0.96 ± 0.1. (auth)

26607 THE OPTICAL MODEL AND PROTON TOTAL REACTION CROSS SECTIONS. E. J. Burge (King's Coll., London), R. A. Giles, and P. E. Hodgson. Proc. Phys. Soc. (London), 81: 832-40(May 1, 1963).

The relation between the calculated total reaction cross section and the optical model parameters is investigated for 17 Mev protons on copper. For both the real and imaginary central potential a Saxon-Woods form factor is used with a Thomas-type spin–orbit potential. A semi-automatic search procedure to find the parameters corresponding to the optimum fit to the elastic scattering is developed. A method is described for the derivation of the optimum adjustments of some or all of the parameters to produce a required change in the predicted reaction cross section with minimum departure from the optimum fit to the elastic scattering results. A 3% change in the reaction cross section can be accommodated for the reaction studied. The scattering of 17 Mev protons by carbon is also briefly considered. (auth)

26608 THE ROLE OF VIRTUAL EXCITATIONS IN THE SCATTERING OF NUCLEONS BY NUCLEI. C. A. Edvi-Illes (Univ. of Melbourne). Proc. Phys. Soc. (London), 81: 856-62(May 1, 1963).

Using a simple nuclear model it is shown that some of the low-lying resonances in the scattering of neutrons by C^{12} are possibly consequences of the virtual excitation by the neutrons of the 2^+ first excited state at 4.43 Mev in C^{12}. (auth)

26609 SPIN RELAXATION OF A ROTATING PAIR OF NUCLEI. S. Clough (University Coll., Banger, North Wales). Proc. Phys. Soc. (London), 81: 863-7(May 1, 1963).

Rapid rotation of an assembly of dipolar coupled nuclei has a profound effect on the nuclear magnetic resonance absorption spectrum. In turn, this affects the broadening caused by random fields even when the correlation frequency greatly exceeds the rotation rate. This broadening is considered for a rotating pair of I = ½ nuclei, and it is concluded that rotation may reduce the broadening due to very rapidly fluctuating fields. In this case the broadening depends on the degree of overlap of the frequency spectra of off-diagonal elements of the density matrix. When the angle between the rotation axis and the external magnetic field is 54.7° a continuous transition from almost no overlap to complete coincidence is obtained with rising rotation speed. For slowly varying fields, on the other hand, broadening may be increased by rotation. (D.C.W.)

26610 NUCLEAR AND RELATIVISTIC EFFECTS IN ATOMIC SPECTRA: [PART] II. A. P. Stone (St. Stephen's Coll., Delhi). Proc. Phys. Soc. (London), 81: 868-76 (May 1, 1963).

The reduction of a relativistic wave equation for any atom to an approximately relativistic form is completed by considering the close approach of particles. The non-hyperfine structure electronic hamiltonian is given as far as terms in $1/c^2$ and m/M_A. The contact interactions differ from those found previously, expressions for one- and two-electron atoms being given explicitly. Some new isotope shift terms are derived as a correction to the normal mass effect. A relation satisfied by the wave function is obtained. (auth)

26611 PRODUCTION OF ^{57}Co USING JAERI-LINAC. Satoru Funahashi and Kyuya Kotajima. Radioisotopes (Tokyo), 12: 60-2(Feb. 1963). (In Japanese)

Carrier-free, pure Co^{57} was obtained by irradiating Ni targets with the 20-Mev γ radiation of the JAERI linac machine. The $Ni^{58}(\gamma,n)Ni^{57}$ reaction ultimately yields Co^{57} which is separated by an ion-exchange process. The Co^{57} thus obtained will be used for studying the Mössbauer effect. (TTT)

26612 EARLY HISTORY OF CARBON-14. Martin D. Kamen (Univ. of California, San Diego). Science, 140: 584-90(May 10, 1963).

A personal account is presented of the circumstances surrounding the discovery of C^{14}. The research in the 1930's and 1940's on nuclear reactions producing C^{14} is described in some detail. The surprising discovery of the $N^{14}(n,p)C^{14}$ reaction is recounted. The unusually long half life of C^{14} and some possible causes are discussed. (D.L.C.)

26613 CONCERNING A NEW MEASUREMENT METHOD FOR DETERMINATION OF SHORT LIFETIMES OF EXCITED NUCLEAR STATES AND MEASUREMENT OF THE LIFETIME OF THE 85-kev LEVEL OF Ra^{224}. Friedrich-Welhelm Richter (Universität, Marburg, Ger.). Sitzber. Ges. Befoerder. Ges. Naturw. Marburg, 82: 19-51(1960). (In German)

The back-scattering technique for determining the lifetimes of excited states is discussed. The Doppler method and the length-of-decay method for back-scattering measurements are described. A critical evaluation was made of

previous methods. Principles of the method employing back-scattering techniques are listed. The electron microscope, the magnetic-field arrangement for wide-angle focusing of the conversion electrons on the scintillation counter, a counter for back-scattered particles and alpha particles, and electronic circuits are described. Results of test measurements with the electron microscope are presented. Measurements were made of the lifetime of the 85-kev state of Ra^{224} and the quadrupole moment was determined from the measured lifetime. (M.C.G.)

26614 AN INVESTIGATION OF THE $P^{31}(p,\gamma)S^{32}$ REACTION AT THE PROTON ENERGIES 642 kev, 812 kev, 1116 kev, and 1147 kev. Erik Spring (Univ. of Helsinki). Soc. Sci. Fennica, Commentationes Phy.-Math., 28: No. 6, 1-40(1963). (In English)

Gamma rays from the $P^{31}(p,\gamma)S^{32}$ reaction were investigated at the 642, 812, 1116, and 1147 kev resonances. From yield measurements the resonance strengths $(2J_r + 1)\Gamma_p\Gamma_\gamma/T$ were determined. They are 0.36, 1.9, 1.6, and 4.2 ev, respectively. Both singles and coincidence spectra were measured. Based upon these spectra decay schemes were proposed. Angular distributions were made and the following spins and parities were obtained for the resonance levels: 1^-(642 kev), 2^+(812 kev), 1^+ (1116 kev), and 2^+ (1147 kev). Additional evidence for the spin assignment of the 812 and 1147 kev resonance levels was obtained by angular correlation measurements. For yield and angular correlation measurements the apparatus and the methods of measurements were checked by measuring the well-known 992 kev $Al^{27}(p,\gamma)Si^{28}$ resonance. The yield measurement gave 38 ev for the resonance strength. Angular correlation measurements gave still further evidence for spin 3^+ for the resonance level and the multipole mixture 99% M1 + 1% E2 for the 10.76 Mev gamma transition. (auth)

26615 COHERENT-SCATTERING AMPLITUDE FOR THERMAL NEUTRONS AND YTTRIUM NUCLEI. Yu. S. Kuz'minov, I. I. Yamzin, E. I. Mal'tsev, and N. V. Belov (Inst. of Crystallography and Inst. of Technical Physics, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 7: 767-8(May-June 1963).

The neutron-scattering amplitude b_Y was determined from the diffraction of neutrons by polycrystalline yttrium oxide. The integral intensities of the 222 and 440 peaks of the pattern were used. The b_Y was found to be $+0.816 \pm 0.07 \times 10^{-12}$ cm. (D.L.C.)

26616 PREDICTION OF THE MOST PROBABLE NUCLEAR CHARGE OF PRIMARY FISSION PRODUCTS BY THE PRINCIPLE OF EQUAL CHARGE DISPLACEMENT AND A NEW MASS FORMULA. Juergen Fiedler and Guenter Herrmann (Universität, Mainz). Z. Naturforsch., 18a: 553-4(Apr. 1963). (In German)

Methods for determining the most probable nuclear charge of primary fission products are discussed. Principles of constant specific charge, equal charge displacement, greatest energy release, and minimal potential energy are outlined. Seegers' mass formula was used in calculations of charge distribution. Results were compared with experimental values. (M.C.G.)

26617 RADIATION PARAMETERS OF A 6.12-Mev LEVEL OF Pr^{141}. Hans H. Fleischmann and Friedrich W. Stanek (Technische Hochschule, Munich). Z. Naturforsch., 18a: 555-6(Apr. 1963). (In German)

The resonance between the 6.12-Mev line of the neutron-capture spectra and a level in Pr^{141} was investigated. The effects of temperature and self-absorption were studied. (M.C.G.)

26618 INVESTIGATION OF THE ENERGY DEPENDENCE OF NUCLEAR REACTIONS OF NEUTRONS IN THE ENERGY REGION BETWEEN 12 AND 19 Mev. M. Bormann, S. Cierjacks, E. Fretwurst, K.-J. Giesecke, H. Neuert, and H. Pollehn (Universität, Hamburg). Z. Physik, 174: 1-17(1963). (In German)

Continuing earlier investigations, studies are made of the energy dependence of the cross sections of the following nuclear reactions produced by neutrons in the energy range from 12 to 19 Mev: $P^{31}(n,2n)P^{32}$, $P^{31}(n,\alpha)Al^{28}$, $Cu^{65}(n,2n)Cu^{64}$, $Cu^{65}(n,p)Ni^{65}$, $Zn^{64}(n,2n)Zn^{63}$, $Zn^{64}(n,p)Cu^{64}$, $V^{51}(n,p)Ti^{51}$, $Br^{79}(n,\alpha)As^{76}$, and $O^{16}(n,\alpha)C^{13}$. The results were compared with cross sections calculated according to the statistical theory, considering the competition of γ emission and particle (predominantly neutron) emission from the excited residual nucleus. (auth)

26619 COULOMB CORRECTIONS FOR INTERNAL BREMSSTRAHLUNG. Gerhard Felsner (Universität, Erlangen-Nuremberg). Z. Physik, 174: 43-56(1963). (In German)

Coulomb corrections to the internal Bremsstrahlung associated with allowed β decay were calculated. The Coulomb field was taken into account through the electron wave function. The corrections to the contributions of the intermediate states to the spectrum were evaluated. These corrections did not cancel out when the spectrum was normalized to the emission of one β particle. Hence the corrections to the normalized spectrum were no longer small. The polarization was practically not affected by these Coulomb corrections. Numerical values for P^{32}, S^{35}, and Y^{90} were compared with experimental results. Especially in the high energy part of the spectrum the former discrepancies between theory and experimental yield were removed. (auth)

26620 INVESTIGATION OF THE DECAY OF Ba^{133} AND Cs^{134} BY γ-γ DIRECTIONAL CORRELATION MEASUREMENTS. F. Muennich, K. Fricke, and U. Wellner (Technische Hochschule, Braunschweig, Ger.). Z. Physik, 174: 68-90(1963). (In German)

The directional correlations of the γ-γ cascades following the decay of Ba^{133} were measured: 355–81, 302–81, 79–81, and 276–160 kev. The results of these measurements together with results of other authors yielded the following well-defined values for ths spin of the levels of Cs^{133}: $\frac{7}{2}^+$ (ground state), $\frac{5}{2}^+$ (81-kev level), $\frac{5}{2}^+$ (160-kev level), $\frac{3}{2}^+$ (383-kev level), and $\frac{1}{2}^+$ (436-kev level). The results are discussed in the frame of the shell model. The decay of Cs^{134} was investigated by measurement of the γ-γ directional correlations: 800–600 kev, 600–600 kev, 1.04-Mev–605 kev. A discussion of these results yielded for the mixing proportion δ of the gamma radiation from the transition of the second to first 2^+ state in Ba^{134} a value $\delta = -0.50 \pm 0.05$ in contradiction to the theory of Davydov and Filippon. Spin 2 was obtained for the 1.64-Mev level of Ba^{134}; the parity of this state is probably negative. (tr-auth)

26621 A STUDY OF THE LOW EXCITED STATES OF Ti^{48}. Robert Arnold Ristinen. Thesis, Boulder, Colo., Univ. of Colorado, 1962. 135p.

In order to provide information on the structure of nuclei with incompletely filled $1f_{\frac{7}{2}}$ neutron and proton shells, the low excited states of Ti^{48} were studied by examining the γ- and β-ray spectra following the decay of V^{48}. This study utilized a large-luminosity, double-focusing, $\sqrt{2}\pi$ β-ray spectrometer and single- and multiple-detector γ-ray scintillation spectrometers with associated coincidence circuitry and pulse-height analysis systems. The internal and

external conversion (in uranium) electron spectra were examined with the β-spectrometer over a range of transition energies from 20 kev to 2.5 mev. The energies and relative intensities of the observed nuclear transitions are reported and discussed. In addition to finding two previously unseen transitions (945 kev, 2.64 Mev) and a new energy level, the energies of the other excited states are defined more accurately than in previously published work. A revised level scheme, which incorporates the findings of this study, was constructed for Ti^{48}. Systematic comparisons were made between the revised level scheme of Ti^{48} and the level structure of neighboring nuclei. Several theoretical descriptions of nuclear structure were also compared to the revised level scheme. It is concluded that none of the present nuclear models account fully for the observed structure, but that many of the observed features are explicable in terms of current theory. (Dissertation Abstr.)

26622 LEVELS IN RARE EARTH NUCLEI. Wilford Neil Shelton. Thesis, Tallahassee, Florida State Univ., 1962. 99p.

Levels in 2 even-even nuclei Dy^{164} and Gd^{158} and in the odd-A nucleus Dy^{165} have been investigated with the (d,p) reaction using 12-Mev deuterons accelerated with the F.S.U. tandem Van de Graaff. Levels in Dy^{164} and Gd^{158} were also investigated by inelastic proton scattering. The protons produced were analyzed with a 60 cm Browne-Buechner-type magnetic spectrograph, and were detected on 100 cm of nuclear-emulsion plates. The (p,p′) runs were made at 90 and 133° with respect to the incident beam; the (d,p) runs were made at 25, 35, 45, and 65° on Dy^{163}; at 25, 45, and 65° on Gd^{157}; and at 45, 65, and 133° on Dy^{164}. Ground-state Q values were found to be 5706 ± 5 kev for the $Gd^{157}(d,p)Gd^{158}$ reaction, and 5434 ± 5 kev for the $Dy^{163}(d,p)Dy^{164}$ reaction. These Q values were relative to the $C^{13}(d,p)C^{14}$ ground state Q value taken as 5951.3 ± 0.8 kev. The following levels were assigned in Dy^{164} from the energy systematics: 72 kev, 2+; 240 kev, 4+; 503 kev, 6+; 761 kev, 2+; 827 kev, 3+; 919 kev, 4+; 1040 kev, 5+. A new level in Gd^{158} at 1359 kev was assigned as 4+. (Dissertation Abstr.)

26623 NUCLEAR ELASTIC SCATTERING OF MONOENERGETIC GAMMA RAYS FROM THERMAL NEUTRON CAPTURE. Carlton Stanley Young. University Park, Penna., Pennsylvania State Univ., 1962. 124p.

The development of a source of monoenergetic γ rays from neutron capture in various elements placed in the thermal neutron flux of the 200-kw Penn State Research Reactor is described. The properties of the γ-ray beam, which determine its usefulness in scattering experiments, are measured or derived. The measurement of nuclear-elastic-scattering cross sections of the neutron-capture γ rays from several heavy nuclei (Ta, Hg, Pb, and Bi) at energies directly below the neutron threshold is described. These were, in general, less than 1 millibarn. These cross sections, when compared to the results of others using sources with broad energy spectra, indicate that the nuclear levels are discrete for these energies. A cross section of 650 ± 60 millibarns was observed for scattering of the 7.285-Mev γ ray from Pb^{208}. The angular distribution of the 7.285-Mev radiation indicates a spin of 1 for the 7.285-Mev state in Pb^{208}. A self-absorption experiment determines the width of the level to be 0.65 ± 0.20 ev. A search for additional levels gave negative results and implies a level spacing of the order of 3000 ev for dipole levels similar to the one observed here in Pb^{208}. (Dissertation Abstr.)

26624 ASSOCIATED PARTICLE SPECTROMETER STUDY OF Cr^{51}. John Angus Becker. Thesis, Tallahassee, Florida State Univ., 1962. 65p.

An associated-particle time-of-flight spectrometer and its calibration are described in detail. The spectrometer utilizes a NaI(Tl) crystal for detection of the associated γ rays in (p,n) reactions since the good γ-ray spectroscopy is necessary for problems in heavy nuclei. Use of NaI(Tl) also permits the study of γ-ray pulse-height distributions in coincidence with particular neutron groups. A tunnel diode time-to-height converter is described; the fast circuitry associated with the spectrometer is capable of nanosecond operation. The spectrometer has been calibrated with the monoenergetic neutrons of the $Li^7(p,n)$ reaction and is linear over a neutron energy range from 0.25 to 3.00 Mev. Prompt γ-γ coincidence curves have been examined using the prompt radiation of Co^{60}. The full width at half maximum of the prompt curve is 2.8 nanoseconds, equivalent to an energy resolution of 4% for a 1-Mev neutron if the flight path is 1 meter. The spectrometer has been used to study the low lying levels of Cr^{51}. We find that the γ-ray de-excitation of the second excited state of Cr^{51} is a direct ground state transition rather than a cascade through the first excited state. (Dissertation Abstr.)

26625 A STUDY OF THE (p,α) REACTION ON Be^9 AND B^{11}. Harry Richard Blieden. Thesis, Tallahassee, Florida State Univ., 1962. 195p.

In order to obtain a better understanding of the (p,α) reaction in light nuclei and to obtain information about the ground-state structure of Be^9 and B^{11} as well as about the highly excited states of B^{10} and C^{12}, the reactions $Be^9(p,\alpha)Li^6$ and $B^{11}(p,\alpha)Be^8$ were studied in detail. Excitation functions and angular distributions for the reaction products were obtained in the range of proton bombarding energies from 3.50 to 12.50 Mev. Solid-state detectors were used to detect the outgoing α-particles. A 256-channel analyzer recorded the spectra. In order to carry out a distorted-wave Born-approximation (DWBA) calculation of the $Be^9(p,\alpha)Li^6$ reaction, it was necessary to measure the elastic scattering of protons from Be^9 and the elastic scattering of alpha particles from Li^6. The optical potentials for Be^9 plus p and for Li^6 plus α were then obtained by fitting the elastic scattering data with an optical model calculation, using a computer program. A comparison of this calculation with the plane-wave calculations for the direct and exchange processes was made. The effects of strong coupling between the elastic and inelastic scattering in the incident and exit channels of this reaction are discussed, as well as the validity of the assumptions of the optical model as applied to Li^6 and Be^9. (Dissertation Abstr.)

26626 THE COMPOUND ELASTIC SCATTERING OF FAST NEUTRONS BY LEAD-208. Jerry Duke Brandenberger. Thesis, Austin, Tex., Univ. of Texas, 1962. 56p.

An attempt is made to measure the differential compound elastic scattering of neutrons of energies between 1.5 and 4.2 Mev by Pb-208 using a method based on the large dissimilarity between the energy-level schemes of Pb-206 and Pb-208, and based further on the assumption that the shape of elastic scattering of neutrons from these two nuclei is essentially the same. The elastic differential cross sections of Pb-206 and Pb-208 for 1.52-, 1.79-, 2.03-, and 4.2-Mev neutrons were measured. The difference in the cross sections of the 2 isotopes at these energies was compared to the compound elastic cross sections of Pb-208 calculated from Hauser-Feshbach theory using the optical model to compute the penetrabilities. For 4.2-Mev neutrons, there

is excellent quantitative agreement between experimental and theoretical values. At lower energies, the measured angular distributions are unsymmetrical about 90°, which is contrary to Hauser-Feshbach theory. It is shown that the statistical assumption of the Hauser-Feshbach theory is not experimentally fulfilled for Pb-208 below 3 Mev. (Dissertation Abstr.)

26627 ELASTIC AND INELASTIC SCATTERING OF PROTONS BY CARBON 12 FOR PROTON ENERGIES BETWEEN 20 AND 31 Mev. Justin Kirk Dickens. Thesis, Los Angeles, Univ. of Southern California, 1962. 196p.

The angular distributions of protons elastically scattered by C-12 for proton energies between 20 and 31 Mev were measured. For angles smaller than 50°, the shape of the angular distribution is nearly independent of the incident proton energy; however, for angles larger than 70° this shape is strongly dependent upon the incident proton energy. The first minimum occurs between 58 and 63°. The first maximum occurs between 63 and 80°. The elastic differential cross sections were analyzed by using a diffuse-surface optical model of the nucleus for a wide range of parameters. Angular distributions for scattering leading to the excitation of the 4.4-Mev, 7.7-Mev, and 9.6-Mev states were measured for energies between 20 and 31 Mev. Angular distributions for scattering leading to the excitation of the 12.7-Mev state were measured for 28-Mev and 31-Mev protons. Angular distributions for scattering leading to the excitation of 14.0-Mev, 15.1-Mev, and 16.1-Mev states were measured for 31-Mev protons. For all levels studied the inelastic scattering is predominantly peaked in the forward direction. Experimental results of inelastic scattering are discussed in relation to predictions of inelastic scattering theories. Integrated partial cross sections were obtained from the inelastic scattering angular distributions. These cross sections for excitation of the 4.4-Mev, 7.7-Mev, and 9.6-Mev states gradually decrease with increasing proton energy, as expected. (Dissertation Abstr.)

26628 NUCLEAR SPECTRA OF THE ISOTOPES OF SAMARIUM. Robert Arthur Kenefick. Thesis, Tallahassee, Florida State Univ., 1962. 199p.

Level schemes for a large number of Sm isotopes were obtained by high-resolution magnetic analysis of the reaction products in (p,p′) and (d,p) reactions. Experimental equipment and procedures and preparation of the Sm targets are described. Over 500 new levels in Sm isotopes were found in the excitation regions 0 to 2 Mev for (p,p′) experiments and 0 to 4 Mev for (d,p) experiments. In the case of stripping to the even-even residual nuclei Sm^{148} and Sm^{150}, the intensities of groups in the region 0 to 1.9 Mev were found to be reduced by a factor of 5 or more relative to groups above ~1.9 Mev excitation. The level density increases rapidly at this excitation. The 6+ ground-state rotational level in Sm^{154} has been found at 548 kev. A level at 1045 kev in Sm^{152} is interpreted as the 4+ rotational state on the 0+ β-vibrational state at 685 kev. A weak group has been observed at 1165 kev in Sm^{148}, which may be a member of the 2-phonon triplet. By plotting ln N(E) against E, where N is the number of states and E is the excitation, a constant slope over a large range of excitation was found. Ground-state Q values observed in the experiments are reported. (M.P.G.)

26629 DISTORTED WAVE EFFECTS IN PROTON INELASTIC SCATTERING. Thomas Joseph Menne. Thesis, Los Angeles, Univ. of California, 1963. 112p.

The direct-interaction differential cross section for the inelastic scattering of protons on complex nuclei is determined in the distorted-wave Born approximation. The incoming and outgoing wave functions are assumed to have the simple, analytical form originally suggested by McCarthy and Pursey, and are designed to simulate the distortion effects of the nuclear optical potential. These wave functions include a "surface" term and a "focus" term. The latter can be neglected for α particles because of their strong absorption in nuclear matter, but it is quite strong for protons. The amplitude of the focus term is assumed to have a Gaussian distribution about the focal point as center. The empirical expression for the distorted waves involves a number of parameters, most of which can be extracted from optical-model wave functions. The behavior of these quantities under variation of the Saxon-well optical-model parameters is investigated. Where possible, quantitative relationships are established between these two sets of parameters, so that a meaningful physical interpretation can be attributed to the quantities appearing in the McCarthy-Pursey model. A comparison is also made between the values of the theoretical parameters obtained from optical-model wave functions and those values required to fit the experimental inelastic scattering data. The implications of the differences between their values are discussed. The model, upon which this work is based, is contrasted with the model of N. Austern, in which the distorted wave functions are expanded in partial waves. (Dissertation Abstr.)

26630 THE EFFECT OF THE COULOMB FIELD ON THE ENERGY SPECTRUM OF ELECTRONS EMITTED IN BETA DECAY. Jane van Winkle Morgan. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 107p.

The effect of the Coulomb field on particles emitted in β decay is calculated with the use of dispersion-relation techniques. A study of the analytic properties of the β decay amplitude, i.e., the matrix element between the initial and final states of the decaying system, reveals an integral equation relating the various parts of the amplitude. Solution of this equation subject to the boundary conditions of the physical system gives enough information to determine the Coulomb factor. The partial wave decay amplitudes have phases equal to the Coulomb scattering phase shifts, and the final expression for the Coulomb factor includes exponential functions of integrals involving these phases over the entire real axis of the energy variable. Symmetry requirements determine the negative energy phases. In case the potential allows bound states, the Coulomb factor also includes a product involving the bound state energies. These integrals and products are evaluated. The effect of a finite nuclear charge distribution is calculated with the assumption of an exponential distribution. The correction to the Coulomb factor turns out to be negligible for all naturally occurring energies. Only if the wave length of the emitted particle were to approach the radius of the nucleus would the effect be noticeable. (Dissertation Abstr.)

26631 BLACK-BODY DISTRIBUTION LAW IN SEMI-CLASSICAL RADIATION THEORY. Joseph Henry Eberly. Thesis, Stanford, Calif., Stanford Univ., 1962. 80p.

A formalism was developed, employing an improved semi-classical theory of electrodynamics, with which it is possible to treat interacting systems of radiation and large or small numbers of atoms. Several standard problems in radiation theory, including radiation reaction, spontaneous emission, and the black-body distribution law, are discussed and results are compared with the corresponding predictions of quantum electrodynamics. The improved

semi-classical radiation theory, called "neoclassical", differs from the ordinary semi-classical theory. The neoclassical theory takes consistent account of the effect of the atoms on the electromagnetic fields, as well as the effect of the fields on the atoms. The neoclassical theory avoids the use of perturbation theory in the usual sense, and does not introduce the concept of transition probability. The neoclassical theory is based on the attempt to integrate Schrödinger's equation directly. Because of the field-atom and atom-field couplings inherent in the neoclassical approach, the basic equations are nonlinear and tractable only in the cases of a single atom interacting with the field (in which case the nonlinear equations may be approximately solved) and that of a very large number of atoms interacting at once (in which case the equations become linear). In the single-atom situation the results of earlier investigators were extended; the explicit solution of the basic set of equations was completed in terms of the incomplete elliptic integral of the third kind. In the case of many atoms a dynamical theorem was derived relating the time average field energy to the time average of the sum of the squares of the atomic dipole moment and its time derivative. The introduction of thermal considerations then led to the Planck blackbody law. (Dissertation Abstr. 23: May 1963)

26632 GAMMA-GAMMA DIRECTIONAL CORRELATIONS IN Eu^{149} DECAY. Carl Alfred Ventrice. Thesis, University Park, Penna., Pennsylvania State Univ., 1962. 94p.

Gamma-gamma directional correlation measurements are performed on the radiation which arises from the electron-capture decay of Eu^{149} in order to determine the spins of the excited states of Sm^{149}, which arise from this decay, and the multipolarity of the de-excitation radiation. Slow and fast-slow coincidence techniques were used in conjunction with an RIDL 400 channel analyzer. In addition, coincidence and half life investigations were performed in order to establish the existence of a gamma transition between the 558.3 and 277.2 kev levels of Sm^{149}. Spins of $^7/_2$, $^9/_2$, $^9/_2$, $^7/_2$ or $^{11}/_2$, and $^7/_2$ were assigned to the 22.5, 277.2, 350.2, 528.6, and 558.3 kev states of Sm^{149} respectively. The 178.4, 72.9, 327.7, 281, and 277.2 kev gamma transitions from the decay were all found to contain quadrupole admixtures of 30% or greater. The spin and quadrupole admixture assignments were found to be consistent with beta and gamma decay theory. (Dissertation Abstr. 23: May 1963)

26633 DECAY OF THE SHORT-LIVED RADIOISOTOPES Si^{26}, S^{30}, Na^{26}, AND Al^{30}. Edward Lee Robinson. Thesis, Lafayette, Ind., Purdue Univ., 1962. 233p.

Some isotopes with short half lives, previously unobserved or uninvestigated, were produced using the He^3 beam of the Purdue University cyclotron and neutrons from the reaction $Li^7(d,n)Be^8$ using the deuteron beam of the cyclotron. Bombardment of high purity natural magnesium with 8-Mev He^3 ions yielded, in addition to decays of known isotopes, a (2.22 ± 0.11)-sec activity. Half life studies indicated that this activity was due to the decay of a positron-emitting isotope with a maximum positron kinetic energy greater than 3.5 Mev. The features of the gamma spectrum, with the exception of a weak line at 824 ± 15 kev, could be understood in terms of the decay characteristics of known radioisotopes. An internally consistent argument based on the known decay characteristics of reaction products that may be expected from energy considerations, the results of half life studies, experimental gamma spectra, and nuclear systematics, was made to support the conclusion that the (2.22 ± 0.11)-sec half life is that of Si^{26} produced in the reaction $Mg^{24}(He^3,n)Si^{26}$, and a consistent decay scheme is proposed. The $Si^{26}-Al^{26}$ mass difference is 4.96 ± 0.08 Mev. He^3-ion irradiation of high purity natural silicon yielded an activity with a half life of 1.35 ± 0.10 sec in addition to activities associated with well-known radioisotopes. A (677 ± 10)-kev gamma ray was associated with the 1.35-sec half life. Decomposition of decay-curves constructed from data obtained by observing annihilation radiation as well as positrons with energies in excess of 3.15 Mev also indicated the presence of a 1.35-sec activity. The beta spectrum in coincidence with two annihilation quanta extended to approximately 5.0 Mev, a higher energy than can be accounted for by positrons from the known reaction products. The beta spectrum in coincidence with the (677 ± 10)-kev gamma ray had an end-point energy of 4.30 ± 0.15 Mev. The assignment of the (1.35 ± 0.10)-sec activity to the decay of S^{30}, produced in the reaction $Si^{28}(He^3,n)S^{30}$, and the proposed decay scheme are supported by arguments formulated from the known characteristics of reaction products, half life studies using both beta and gamma radiation, the features of the experimental beta and gamma spectra, beta-gamma coincidence spectra, nuclear systematics, and nuclear theory. A $S^{30}-P^{30}$ mass difference of (6.01 ± 0.15)Mev was obtained. The bombardment of high purity natural magnesium targets with fast neutrons from the $Li^7(d,n)Be^8$ reaction (E_d < 24 Mev) yielded, in addition to activities associated with well-known isotopes, an activity having an experimental half life of 1.03 ± 0.06 sec. Scintillation spectrometer measurements showed a (1.82 ± 0.03)-Mev gamma ray and a (6.7 ± 0.3)-Mev beta group decaying with the 1.03-sec half life. The 6.7-Mev beta group was found to be in coincidence with the 1.82-Mev gamma ray. Assignment of the (1.03 ± 0.06)-sec half life to Na^{26}, produced in the reaction $Mg^{26}(n,p)Na^{26}$, and the proposed decay scheme are supported by internally consistent arguments based on known characteristics of the reaction products and their decay modes, half life studies using both beta and gamma radiation, features of experimental beta and gamma spectra, and nuclear systematics. A Na^{26}-Mg^{26} mass difference of 8.5 ± 0.3 Mev was derived. High purity natural silicon targets bombarded with the fast neutrons yielded, in addition to well-known radiations, a beta spectrum with an end-point of 5.05 ± 0.25 Mev and two gamma rays with energies of 2.26 ± 0.03 Mev and 3.52 ± 0.03 Mev. These gamma rays and the beta group decayed, within experimental error, with the same half life, 3.27 ± 0.20 sec. The assignment of this activity to Al^{30} and the proposed decay scheme are supported by considerations involving the decay schemes of the well-known isotopes produced, half life studies using portions of both the beta and gamma spectra, and nuclear systematics. The resulting $Al^{30}-Si^{30}$ mass difference is 7.29 ± 0.25 Mev. An attempt was made to produce A^{34} by bombarding high purity natural sulfur and Ti^{42} by bombarding high purity natural calcium with 8-Mev. He^3 ions. The results were negative. (Dissertation Abstr. 23: May 1963)

26634 PHOTONEUTRON CROSS SECTIONS FOR LANTHANUM AND PRASEODYMIUM. Laurence Bliss Rice. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 99p.

The effect of shell closure on the photodisintegration giant resonance was investigated by measuring the (γ,n) cross sections of lanthanum and praseodymium using the bremsstrahlung from the 70 Mev electron synchrotron. The photoneutron yield points were measured, at .5 Mev

intervals from 8 to 30 Mev, using the Halpern-type detection system. The synchrotron beam was monitored by an ionization chamber calibrated to ±2%, also the neutron detection efficiency was calibrated by using a Ra–Be neutron source known to ±3%. The yield curve was determined using the average of 24 independent determinations. The daily fluctuations in the yield points were less than ±2%, and the uncertainties assigned to the yield points were computed from the standard deviation of the independent runs. The method of Penfold and Leiss was used to extract from the yield curves the total neutron cross section, $\sigma_\mu = \sigma(\gamma,n) + \sigma(\gamma,pn) + 2\sigma(\gamma,2n) + \cdots$. The results show that the half width at half maximum cross section of lanthanum is less than that of praseodymium, being 3.2 + .3 and 3.6 ± .3 Mev respectively. It was possible to fit both cross sections, corrected for the multiplicity in $\sigma(\gamma,2n)$, with a Lorentz curve. The maximum cross sections were 304 ± 15 and 305 ± 15 mb, occurring at 14.5 ± .3 and 14.8 ± .3 Mev, respectively for lanthanum and praseodymium. (Dissertation Abstr. 23: May 1963)

26635 A STUDY OF NUCLEAR LEVELS EXCITED BY DEUTERON STRIPPING REACTIONS WITH Zr^{90}, Zr^{91} AND Sr^{88} TARGET NUCLEI. Ralph Laughlan Preston. Thesis, Bloomington, Ind., Indiana Univ., 1962. 61p.

The 11.1 Mev deuteron beam of the Indiana University cyclotron was used to excite nuclear states in the three shell model isotopes Sr^{89}, Zr^{91}, and Zr^{92} by means of deuteron stripping reactions. Excitation energies and proton angular distributions of low-lying states were measured using a 20 inch radius double-focussing magnetic spectrometer. The orbital angular momentum transfers, the final state spins, and cross section reduced widths were determined by comparison of the measured angular distributions of the excited states with Butler stripping theory. Assignments of the orbital angular momentum transfers in the strontium reaction were also obtained by comparison with distorted wave Born approximation calculations. A shell model calculation of the energy level spectrum of Zr^{92} gives fair agreement with experimental results. The zero-order energy levels used in the calculation were taken from the measured Zr^{91} excitation energies. (TCO)

26636 THE ANGULAR AND ENERGY DISTRIBUTION OF ALUMINUM PHOTOPROTONS. W. Reed Johnson. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 181p.

The energy and angular distribution of photoprotons from aluminum was measured for protons in the energy range, 8 to 25 Mev. A collimated bremsstrahlung beam from the University of Virginia's 65 Mev synchrotron was used as a source of gamma radiation, with a maximum gamma energy of 63 ± 0.5 Mev for all measurements. Photoprotons were counted by two silicon p-n junction detectors arranged as a summing counter. The energy response of the summing counter for protons was essentially linear for energies from 4 to 11 Mev. To extend the energy range of the measurements, and eliminate the effect of high energy protons, aluminum energy reduction foils were placed between the target and detector. Protons were counted at detector to beam-direction angles of 40, 60, 90, and 130°. Angular distributions were determined for each of several proton energy ranges, and were fitted with a curve of the form, $F(\theta) = a + (b\sin\theta + p\sin\theta\cos\theta)^2$. Proton energy spectra were obtained by successive subtractions of the high energy proton contribution to each set of data, measured with a particular energy reduction foil in place. Peaks were identified at proton energies of roughly 9, 13.5, 14.7, 19 and 21 Mev. An interpretation of these results was made using the direct interaction model. Silicon p-n junction detectors used for photoproton detection were fabricated by a high temperature diffusion of phosphorus into p-type of silicon having a resistivity of about 1,300 ohm-cm. Detectors were made by this process with areas of up to 2 cm^2, to which a reverse bias of 400 to 500 volts could be applied. The detectors had an energy resolution for 5.3 Mev alpha particles of the order of 1%. The summing counter was calibrated by measuring its response to the monoenergetic proton groups of about 9, 7, 4.5, and 4.2 Mev produced in the $B^{10}(d,p)B^{11}$ reaction. The response of single detectors to protons was also measured. The results indicated that the width of the space charge layer (sensitive portion for charged particle detection) of the p-n junctions was greater by almost a factor of 2 than was calculated. No explanation of this effect was found, with the exception of a possible failure of the calculational model for high reverse bias values. (Dissertation Abstr. 23: May 1963)

26637 SPIN-ORBIT COUPLING IN THE OPTICAL MODEL FROM A STUDY OF P-WAVE STRENGTH FUNCTIONS. Adeshwar Preshad Jain. Thesis, Ithaca, N. Y., Cornell Univ., 1962. 120p.

The optical model was successful in explaining the nucleon-nucleus interaction at high excitation energies. The model was proved to be good at very high excitation energies (≳20 Mev) and also by Feshbach, Porter, and Weisskopf at low excitation energies ~8 Mev. Although the potential model shows a smooth variation of cross section with energy over the limited energy range, it predicts giant resonances, which are a few Mev wide and are characteristic of stationary states in a potential well. For S-wave neutrons, resonances are observed whenever the phase of the wave at the surface is $\pi/2$. These states depend on R/λ, where R is the nuclear radius and λ, the wavelength of the particle inside the nucleus. The resonance condition can be achieved either by varying the depth of the well or its range R. In the experiment that is described, it is the radius R that is varied by varying atomic weights. The incident particles used are neutrons, which automatically give an excitation energy of ~8 Mev to the compound nucleus for medium weight nuclei. This is because of the binding energy of the last neutron in the nucleus. The optical model, in general, contains a real part, an imaginary part and a spin-orbit part. The purpose of the experiment was to measure the strength of spin-orbit coupling by observing the splitting of 3P giant resonance around A = 100 into $3P_{3/2}$, $3P_{1/2}$ for P-wave neutrons, due to the possible presence of spin-orbit coupling in the optical model potential. The symbol 3 is the quantum number characterizing the giant resonance and $3/2$, $1/2$ are the channel spins, where channel spin is the vector sum of spin and orbital angular momentum for the P-wave neutrons. The total neutron cross section measurements from 10 to 100 kev were carried out using the Brookhaven-A.E.C.L. fast chopper at the N.R.U. reactor at Chalk River, for the elements in the range of $A \cong 100$. The data indicate a splitting corresponding to a spin-orbit strength of ~16 Mev, in contrast to the 8 Mev as observed by Björklund and Fernbach from a study of high excitation proton elastic scattering and polarization data. However, $Cd^{112,4}$ seems to be an exception. For a spin-orbit strength of 16 Mev, if one of the peaks in the curve of strength function versus atomic weight is around A = 96, then the other is at cadmium. Because of the disagreement with cadmium, the second peak is not defined. More measurements are proposed around A = 112.4 to ascertain this ambiguity. (Dissertation Abstr. 23: May 1963)

26638 DIFFERENTIAL SCATTERING OF 15-Mev NEUTRONS USING TIME-OF-FLIGHT TECHNIQUES. Cecil Ivan Hudson, Jr. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 137p.

Results of the measurement of the differential cross section of 15.2 Mev neutrons scattered elastically from U, Th, Bi, and Ta are presented. An associated particle time-of-flight system with an energy resolution at 15.2 Mev of 2.5 Mev was used to separate the elastically and inelastically scattered neutrons. Monte Carlo calculations were used in correcting the data for multiple scattering and attenuation of the neutrons in the cylindrical scattering samples. The diameters of the scatterers used were from 0.4 to 0.7 of the mean free path of a 15.2 Mev neutron in the scattering material. The corrected data were compared with the theoretical optical model predictions of Bjorklund and Fernbach. The purpose of this experiment was to investigate the scattering of 15.2 Mev neutrons by deformed nuclei, in order to determine the extent of agreement with theoretical studies of deformation effects in the Optical Model. U, Th, and Ta have highly deformed nuclei. Bi, a spherical nucleus, was measured for comparison. In comparing the experimental differential cross sections with the theoretical predictions of Bjorklund and Fernbach, significant variations were observed in the case of U, Th, and Ta, with the angular distribution appearing somewhat "washed-out" compared with the theoretical predictions. It was concluded that these variations might be due to nuclear deformations, since a similar effect was seen in scattering high energy electrons from deformed nuclei. The total elastic cross sections were also measured by integrating the differential cross sections, and were found to be for U, 3.21 ± .16 barns, for Th, 3.13 ± .14 barns, for Ta, 2.63 ± .13 barns, and for Bi, 2.55 ± .13 barns. (Dissertation Abstr. 23: May 1963)

26639 A STUDY OF NEUTRON EVAPORATION IN 42-Mev ALPHA PARTICLE BOMBARDMENTS OF SEVERAL ELEMENTS. Darrell Melvin Drake. Thesis, Seattle, Univ. of Washington, 1962. 178p.

A neutron time-of-flight system was built for use with a 60-in. cyclotron. The system was used to measure the yields, angular distributions, and energy spectra of neutrons produced in bombardments of aluminum, cobalt, niobium, and gold with 42 Mev alpha particles. The measured integrated neutron production cross-sections are 1.0, 2.3, 4.5, and 5.2 barns respectively. Energy spectra (measured from 2 to 10 Mev) were analyzed in terms of a formula corresponding to the superposition of three stages of evaporation. The value of a parameter in this formula related to nuclear level density was in all cases in reasonable agreement with values implied by the Fermi gas model. The angular distributions show backward and forward peaking. The mean values of the nuclear moments of inertia implied by the anisotropies were less than rigid body values. There is evidence for direct interaction contributions to the neutron yields as far back as 100° and at neutron energies as low as 5 Mev. (Dissertation Abstr. 23: May 1963)

26640 ELASTIC SCATTERING OF ALPHA PARTICLES FROM CARBON-12 AND THE $C^{12}(\alpha,p_0)N^{15}$ REACTION FROM 10 TO 19 Mev. Elmer Buzby Carter. Thesis, Tallahassee, Florida State Univ., 1962. 127p.

A useful alpha particle beam of a tandem Van de Graaff accelerator of up to 19 Mev was found. Data were taken of fourteen excitation curves and fifteen angular distributions for the elastic scattering of 10 to 19 Mev alpha particle on C^{12}. The excitation curves show a considerable amount of energy dependent structure, as do the angular distributions. Some data were taken on the reaction $C^{12}(\alpha,p_0)N^{15}$. Only moderate success in fitting the elastic angular distributions was obtained with the optical model and the Akhieser-Pomeranchuk-Blair sharp-cutoff model. The Akhieser-Pomeranchuk-Blair-McIntyre smooth-cutoff model with added resonant effects was relatively successful in fitting the angular distributions. Level parameters in O^{16} between the excitation energies of 14.6 and 21.0 Mev were extracted from the angular distributions and from a qualitative examination of the excitation curves. Some of the more prominent levels were analyzed in terms of the collective model and the cluster model of nuclear structure. Two cluster model and collective model bands were noted; one with spin and parity 0^+, 2^+, 4^+, and 6^+; and another with 1^-, 3^-, 5^-, and 7^-. (Dissertation Abstr. 23: May 1963)

26641 PHOTOPRODUCTION OF POSITIVE PIONS FROM HYDROGEN NEAR THRESHOLD. Maurice Jacques Bazin. Thesis, Stanford, Calif., Stanford Univ., 1963. 164p.

Differential cross sections were measured for positive pion photoproduction on hydrogen at low energies. Pions were produced in a polyethylene target, and the carbon contribution was subtracted by measuring the yield from a carbon target. The gamma rays were obtained from bremsstrahlung of the electron beam of the Stanford 1-Bev linear electron accelerator. The electron beam was not swept out of the path of the gamma beam, and direct electroproduction of pions in the target had to be taken into account. The pions were identified by momentum and range by using a magnet spectrometer and a scintillation counter telescope. Absolute values of the cross sections were obtained by calibrating the solid angle of the magnet with an alpha-particle source. Relative cross sections were also measured using a liquid-hydrogen target. The electroproduction background was eliminated in this case by sweeping the electron beam away from the target. These data agreed with those obtained with the solid target technique within the experimental accuracy of ±5%. The final results are in agreement with the theoretical predictions of Chew et al. as computed by Robinson, but disagree with the predictions of Ball. This disagreement may come from the fact that Ball neglected the small p-wave phase shifts. The threshold value of the photoproduction matrix element was found, by extrapolation using the theory of Chew et al., to be $(15.9 \pm 0.5)\ \mu b\ sr^{-1}$. (TCO)

26642 NUCLEAR RADIATION PHYSICS. Ralph E. Lapp and Howard L. Andrews. Third Edition. Prentice-Hall Physics Series. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1963. 423p. $12.00.

Updated material, including recent discoveries in space radiation, in the field of radiation physics was presented. Thermonuclear reactions for energy release, nuclear quadrupole moments, the Fermi function, beta emission, photon absorption, and parity are discussed. Nuclear radiation, atomic and nuclear structure, ionization chambers, pulse counters, particle accelerators, induced nuclear transformations, neutron physics, nuclear fission, nuclear reactors, and radiation measurements and health protection are the main topics covered. (C.E.S.)

Particle Accelerators

26643 (AERE-GP/R-2475) PROPOSAL FOR A HIGH INTENSITY PROTON GUN USING SPACE CHARGE NEU-

TRALISATION. L. C. W. Hobbis (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Feb. 1958. 21p.

The possibility is examined of achieving space charge neutralization of ion beams within d-c accelerator tubes, particularly with a view to obtaining intense proton beams for injection devices. A design for an accelerating electrode is proposed which should enable neutralization to be obtained over the major part of the trajectory. Some preliminary calculations suggest that a 100 mamp proton beam might be accelerated to 600 kev over about 5 feet without ever exceeding about 1 cm in diameter. (auth)

26644 (IFA/M/27) EINIGE BESONDERHEITEN DER ELEKTRONISCHEN KREISE DES BETATRONS DES INSTITUTS FÜR ATOMPHYSIK. (Some Peculiarities of the Electronic Circuit of the Betatron of the Institute for Atomic Physics). S. Haitrich and I. Leibovici (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). 1962. 17p.

Characteristics of the betatron's electronic circuit are described. Synchronization of the point of entrance and the contraction is discussed. The electronic circuits of the impulse generators are shown. The correction of the calculated circuit is described. (M.C.G.)

26645 (IFA/M-31) DER STAND DER ENTWICKLUNG DER ARBEITEN BEIM BETATRON DES INSTITUTS FUR ATOMPHYSIK BUKAREST. (The State of Development of the Work at the Betatron of the Institute for Atomic Physics, Bucharest). C. C. Iliescu (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). [1962]. 16p.

The construction and most important data on the betatron are described. Work discussed includes: increasing the intensity of the bremsstrahlung, increasing the final energy of the electrons, physical research, dosimetric questions, nondestructive materials testing, and general research. (M.C.G.)

26646 (SLAC-15) MISALIGNMENT AND QUADRUPOLE ERROR PROBLEMS AFFECTING THE CHOICE OF MULTIPLET TYPE FOR SECTOR FOCUSING OF THE TWO-MILE ACCELERATOR. R. H. Helm (Stanford Univ., Calif. Stanford Linear Accelerator Center). Mar. 1963. Contract AT(04-3)-400. 53p.

Calculations for several quadrupole multiplet combinations spaced at sector intervals are presented. Four representative cases—the Spaced Doublet, Close Doublet, Spaced Triplet, and Close Triplet—are considered. These alternative systems are compared in such a way as to provide a basis for deciding which would be more favorable for use in the two-mile accelerator. Consequently the emphasis is on errors whose effects depend on the structure of the multiplet, although some structure-independent effects are included for completeness. Stray magnetic fields, gross misalignments of the accelerator axis, and r-f field asymmetries specifically are excluded from the discussion, since beam perturbations by such effects are expected to be nearly independent of the multiplet type. (auth)

26647 (TID-18783) OPERATING EXPERIENCE WITH THE UNIVERSITY OF COLORADO CYCLOTRON. J. J. Kraushaar, D. A. Lind, M. E. Rickey, and W. R. Smythe (Colorado. Univ., Boulder). [1963]. Contract AT(11-1)-535. 19p.

Performance of the cyclotron and its components is discussed along with problems that occurred in its early operation and the measures taken to correct them. Beam properties obtained are given, and diagrams of the accelerator and certain components are included. (D.C.W.)

26648 UTILIZATION OF THE EXTERIOR BEAM OF THE U-120 CYCLOTRON ALONG THREE DIFFERENT DIRECTIONS. Constantin Popescu (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 841-56(1962). (In Rumanian)

The focusing properties of the magnetic fields in cross section are described, and the means used to establish optimum conditions for their utilization in the case of beam deflection along several directions are indicated. The case of a deflector magnet with plane polar pieces, sector or trapezoid form, is analyzed when the field in the air gap is uniform. Because of the complications in the construction of pole pieces for beam deflection in several directions, it was necessary to abandon the use of the vertical focusing effect from the leak field and to select a simpler construction of the pole pieces. The incidence and the beam output are normal to the side of the pole piece for each deflection direction chosen. The effect of the leak field on the focusing in the median plane (horizontal) is introduced in the calculation under the form of an extension of the limits of the uniform field to the exterior of the pole pieces. The methods used for the utilization of the external beam along three directions and the results obtained are described. (tr-auth)

26649 A 6.5-Mev MICROTRON FOR INJECTING ELECTRONS INTO A SYNCHROTRON. K. A. Belovintsev, A. Ya. Belyak, A. M. Gromov, E. M. Moroz, and P. A. Cherenkov. At. Energ. (USSR), 14: 359-63(Apr. 1963). (In Russian)

The method of preliminary acceleration during the high-voltage injection was chosen to increase as far as possible the electron beam intensity. For this reason, the microtron type accelerator was proposed by V. I. Veksler in 1944 (Doklady Akad. Nauk SSSR, 43: 436(1944)). In order to verify the theoretical conclusions, a microtron, calculated to accelerate the electrons to 6.5 Mev in the first stage, was built. The terminals of the magnet and the plates were fabricated of steel, the yoke of Armco iron. The relative nonuniformity of the magnetic field, measured by the nuclear resonance method, does not exceed 0.3%; it is largest near the yoke. The input of the magnet, when operating at H ≅ 1000 oersted, is 450 w and could be stabilized with an accuracy of about 0.03%. The cathode made of LaB_6 in a Ta tube delivered a stable current of 400 ma and the emitting surface reached a temperature of 1450°C. It was found that the current reaches 22 ma with a pulse duration of about 2 microseconds at the eleventh orbit, being practically constant after the second orbit. (TTT)

26650 HIGH ENERGY ACCELERATORS. [PART] II. Atomics, 16: No. 3, 26; 28-34; 36(May-June 1963).

A review is presented of the historical development of cyclotrons, synchrotrons, and other high-energy circular accelerators. (D.L.C.)

26651 ON THE STARTUP OF THE KARLSRUHE RELATIVISTIC ISOCHRONOUS CYCLOTRON. A. Lerbs (AEG-Forschungsinstitut, Frankfurt am Main). Atomwirtschaft, 8: 265-6(Apr. 1963). (In German)

The design of the 50-Mev isochronous cyclotron for the acceleration of deuterons is described. Operational experience is discussed. (M.C.G.)

26652 BEAM STORAGE IN A BETATRON. L. Šípek (Inst. of Vacuum Electronics, Czechoslovak Academy of Sciences, Prague). J. Nucl. Energy, Pt. C, 5: 15-16(Jan.-Feb. 1963). (In English)

A method of storing an accelerated beam for accelerators with alternating magnetic field is proposed and its experimental realization on a 15 Mev betatron is described. The lifetime of the beam for an energy of 11 Mev was measured as 0.15 sec when the vacuum was 10^{-7} tor; the decay of the beam is caused mainly by radiation losses. (auth)

26653 A NORMAL BEAM WITH LINEAR FOCUSING AND SPACE-CHARGE FORCES. T. R. Walsh (NIRNS, Rutherford High Energy Lab., Harwell, Berks, Eng.). J. Nucl. Energy, Pt. C, 5: 17-22(Jan.-Feb. 1963). (In English)

A differential equation is obtained for the profile of a beam with finite emittance and space-charge. Various special cases are considered and profiles for a non-accelerated beam are given. A phase-space distribution consistent with the non-accelerated case is determined explicitly as far as its Fourier transform. (auth)

26654 THE CYCLOTRON UNIT: MEDICAL RESEARCH COUNCIL. D. D. Vongerg and J. F. Fowler (Hammersmith Hospital, London). Nature, 198: 827-32 (June 1, 1963).

The facilities provided by the medical research cyclotron are described and present applications in medical research are reviewed. The cyclotron provides a fast neutron beam suitable for use in radiotherapy and radiobiological research; deuteron and α particle beams for research in fundamental radiobiology, biochemistry, and activation analysis; and a series of radioactive isotopes with properties different from those produced in nuclear reactors. The completion of the 4-portal beam transport system late in 1962, together with the availability of a new experimental room for the neutron and charged-particle beams outside the main cyclotron radiation shield, increased the effectiveness of the cyclotron for medical applications. (C.H.)

26655 THE ELECTRON CAPTURE PROCESS IN CONVENTIONAL ANNULAR MACHINES. L. Gonella (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nucl. Instr. Methods, 22: 269-91(Apr. 1963). (In English)

Experiments carried out on a 70-Mev synchrotron gave results in disagreement with the current injection philosophy: the yield is insensitive to the matching of the pulse front with the acceptance slope, and when two guns are used together their contributions never add to each other, but the more efficient gun takes over the process or disturbs the capture from the other. These results and a critical review of the available evidence indicate that the donut is saturated at all intensity levels, but not by a space-charge saturation, and suggest that a direct action of the injected beam is responsible for the capture. The dynamics of the injected beam is investigated in a simple model and the results qualitatively generalized to realistic conditions: with the usual high pulse currents the beam pulsates in area and hits the walls within the first turn. The loss of the more energetic electrons shifts toward the orbit the center of mass of the survivors, thus allowing their capture. The process is discussed for single-turn and multiturn injection, in which case a phase-space saturation of the donut occurs; the phenomenological conclusions are in good agreement with the experimental evidence. (auth)

26656 THE TERMINAL ELECTRONIC CIRCUITS OF A PULSED 2 Mev ELECTROSTATIC ACCELERATOR. E. C. Fellows and B. A. Bumford (Associated Electrical Industries, Aldermaston, Berks, Eng.). Nucl. Instr. Methods, 22: 351-7(Apr. 1963). (In English)

The electronic circuitry installed in the high voltage terminal of a 2 Mev electrostatic accelerator is described. The machine may be operated to produce a steady or pulsed beam of positive ions. Pulsed operation is obtained by electrostatic deflection of the low energy beam across a suitable aperture in the top of the accelerator tube. Pulse durations of 2×10^{-8} sec at a repetition rate of 10^6 pulses per second have been obtained. (auth)

26657 INVESTIGATION OF THE MAGNETIC FIELD OF AN ISOCHRONOUS CYCLOTRON. N. F. Verster and H. L. Hagedoorn. Philips Tech. Rev., 24: 106-20(1962-63). (In English)

An isochronous cyclotron under construction enables different kinds of ions to be accelerated to a variable final energy (protons up to a maximum of 25 Mev). In an isochronous cyclotron the influence of the relativistic increase of mass on the revolution frequency is compensated by making the induction $\bar{B}(r)$ of the magnetic field increase with the radius r. The vertical stability of the orbits is ensured by making B vary periodically in the azimuthal direction by means of sector-shaped hills and valleys on the pole pieces. The cyclotron is also fitted with ten pairs of trimming coils, that allow the form of $\bar{B}(r)$ to be varied to meet the demands imposed by the different ionic species and the different final energies. The description of how this complicated field is measured—for ten different excitations of the main coil, in connection with the desired variation of the final energy—and how the more than 10^5 measured values are processed with a computer is given. The final result of the calculations is the value of the currents through the trimming coils needed to give the best approximation to the desired isochronous field. In the course of these calculations, improbable measured values are indicated and replaced. (auth)

26658 LIFETIME AND BEAM SIZE IN A STORAGE RING. C. Bernardini (Laboratori Nazionali del Sincrotrone, Frascati, Italy), G. F. Corazza, G. Di Giugno, G. Ghigo, J. Haissinski, P. Marin, R. Querzoli, and B. Touschek Phys. Rev. Letters, 10: 407-9(May 1, 1963).

A lifetime of the order of 50 hours, corresponding to the residual air pressure of $\sim 5 \times 10^{-10}$ Torr, was reported for a small number of stored electrons. The lifetime depends on the number of electrons in the beam. The lifetime of a given beam is independent of the presence of another beam; so that the effect described must be interpreted as a self-interaction of the particles in each bunch. (C.E.S.)

26659 PROPAGATION OF RELATIVISTIC BEAMS OF HIGH-CURRENT DENSITY CHARGED PARTICLES IN ACCELERATING AND DELAYING ELECTROSTATIC FIELDS. V. P. Ignatenko. Radiotekhn. i Elektron., 7: 1175-84(1962). (In Russian)

High-density charged particle beam motion between plane-parallel electrodes was studied considering relativistic effects. A generalization was obtained for the universal three-halves law at high anode voltage. Conditions for virtual emitters are found, and it is shown that the region of multivalent solution (corresponding to hysteresis) is reduced with increased acceleration voltage. (tr-auth)

26660 FORMATION OF A RELATIVISTIC RIBBON BEAM OF CHARGED PARTICLES. V. P. Ignatenko. Radiotekhn. i Elektron., 8: 127-9(Jan. 1963). (In Russian)

Formation of intense ribbon beams of charged particles in dielectron systems with accelerating intensity of 30 kv was investigated. (tr-auth)

26661 ELECTRON BUNCHING IN A DELAYING FIELD. V. N. Parygin (Moscow State Univ.). Radiotekhn. i Elektron., 8: 591-9(Apr. 1963). (In Russian)

Current harmonics in electron stream interactions with a delaying field system were analyzed. The amplitudes of the first lens harmonics for electrons and waves were found at various velocity ratios. The current harmonic behavior was analyzed at various incoming signal levels. (tr-auth)

26662 FREQUENCY MULTIPLIER IN REFLECTING KLYSTRON. L. A. Belov and M. V. Kapranov. Radiotekhn. i Elektron., 8: 600-11(Apr. 1963). (In Russian)

Binary Fourier series were used in an investigation of high-frequency multiplication in an ordinary reflecting klystron in which the multiplied frequency is found between the reflector and resonator. Asynchronous excitations and auto-oscillation damping by re-excitation, external force amplitude, and multiplicity are analyzed. (tr-auth)

26663 LINEAR ACCELERATOR FOR IONS. German Patent DAS 1,146,990. Apr. 11, 1963. Priority date May 5, 1958, France.

A linear accelerator is described in which the acceleration of the particles is attained by causing them to pass through consecutively arranged fields which are established by serially arranged tubes charged from a high frequency source and through which the ions are passed. Adjacent tubes in the series are connected to opposite terminals of the source so as to be charged to opposite polarities and the particles are accelerated in steps as they progress through the fields. It is known that for very high terminal velocities of the particles extremely long tubes presenting space problems and large high frequency generator apparatus is required. It is nearly impossible to attain an exact tuning to resonance. In order to overcome these disadvantages it is proposed to surround the accelerating tubes coaxially with a cylindrically shaped cavity resonator. For connecting the tubes with the h-f generator, plates are located within the cavity which are attached to the interior surface of the cavity resonator along its mantle lines and to the correspondent tubes. The lines along which the plates are attached correspond to the location of the voltage maximum of the cavity resonator. (Gmelin Inst.)

Plasma Physics and Thermonuclear Processes

26664 (AD-285620) STUDY OF TECHNIQUES FOR A HIGH POWER, FAST WAVE PLASMA AMPLIFIER. First Quarterly Interim Engineering Report. E. Langberg, R. L. Smith, P. Freyheit (Elcon Lab., Inc., Cambridge, Mass.). Aug. 20, 1962. Contract AF33(657)-8852. 45p. (R-8-62-3)

Two processes are described which may lead to low-pressure fast-wave plasma amplification: the cyclotron mode and the new beam scatter mode. A comparison of the two leads to a recommendation that the beam scatter mode be emphasized. The behavior of an electron beam in a low pressure gas is examined and the formulas for the equivalent inductance and conductance are derived. The conditions for power gain are related to beam and gas properties. A plasma device is described in which the required beam can be generated. It consists of electron emitting hot cathode and cesium ion emitting hot anode. The potential distribution and space charge neutralization are discussed. The effective capacitance of the cathode sheath formed at the electron emitter is evaluated. The efficiency of beam scatter amplification is described. A three electrode design is introduced in which ion emission and electron collection are performed by different electrodes. Amplification efficiency potentially higher than 30% is indicated. (auth)

26665 (AFCRL-63-81) MICROWAVE INVESTIGATION OF THE DIELECTRIC WAVEGUIDE PROPAGATION BY MAGNETO-IONIC DUCTS. Technical Summary Report No. 2, April 1, 1960–December 31, 1961. Ing. A. Gilardini (Selenia S.P.A., Rome). July 1962. Contract AF61(052)-145. 56p. (AD-404574)

Theoretical work included completion of the basic theory for propagation along plasma columns in magnetic fields, derivation of Brillouin diagrams, discussion of particularly significant limits and preliminary analyses of the non-uniform plasma case. Experimental work included measurements of basic propagation parameters: transmitted signal, wavelength and group velocity, and of physical plasma parameters such as the electron density. (auth)

26666 (CEA-2264) CARACTERISTIQUES DU PLASMA INJECTE DANS D.E.C.A. II. (Characteristics of the Plasma Injected Into DECA II). P. Lecoustey, H. Luc, J. Tachon, and D. Veron (European Atomic Energy Community and France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1963. 52p.

Deuterium plasma is injected from an electrodeless plasma gun along the lines of force of a static magnetic field. This field is constant over a length of 1 m; it increases thereafter in a 10 to 1 ratio over a 4 m length up to the chamber where the measurements are carried out. Density measurements are performed using Faraday cups and an 8.6 mm microwave interferometer. For instance in a 1600 gauss magnetic field a 0.5×10^{13} deuteron/cm^3 density arises for a plasma with velocity 3×10^7 cm/s. The transverse energy is first determined from the diamagnetic signal amplitude of magnetic loops. The main results are obtained from the study of plasma transmitted through a magnetic barrier by means of measurements made with a Faraday cup, magnetic loops and thermocouples. The results given by these different methods are in good agreement and allow definition for the whole of the plasma flow a mean (θ) value for the ion pitch angle. In a 1600 gauss field, (θ) equal 32 degrees; i.e., mean transverse energy of 360 ev for a plasma with a 930 ev longitudinal energy (a velocity equal to 3×10^7 cm/s). The high value of the transverse energy might be attributed to a pre-compression in the field gradient. Preliminary measurements seem to indicate the possibility of trapping the plasma between two magnetic barriers. (auth)

26667 (CEA-2269) SUR UN CRITERE DE STABILITE AU VOISINAGE DE L'AXE MAGNETIQUE EN SYMETRIE DE REVOLUTION AVEC PRESSION ANISOTROPE. (Concerning a Criterion for Stability in the Vicinity of the Magnetic Axis in Symmetry of Revolution with an Anisotropic Pressure). Laurent Cairo (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses and European Atomic Energy Community). 1963. 9p.

A stability criterion is developed that is given by local m.h.d. CGL displacements in the neighborhood of the magnetic axis of revolution symmetry. As opposed to the case of anisotropic pressure, the criterion is found to be always valid on the magnetic axis. (auth)

26668 (HE-150-211) A SPECTROSCOPIC STUDY OF RECOMBINATION IN A HELIUM PLASMA. F. A. Robben

(California. Univ., Berkeley. Inst. of Engineering Research). Apr. 5, 1963. Contract AF 49(638)-502. 53p.

Recent work on ion-electron recombination has shown that a model involving recombination into highly excited bound levels through electron-electron-ion collisions and transitions between the bound levels through electron-atom collisions as well as the usual radiative processes, is in good agreement with experiment. By making absolute intensity measurements of all the lines of helium emitted from the decaying plasma of an arc jet in the visible and near ultraviolet, the number densities of the excited states of helium were calculated. When interpreted by means of the collisional-radiative recombination model, these measurements give values for $K_{n,n-1}$, the collisional deexcitation rate constant of an excited helium atom from level n to n − 1. The constancy of $K_{n,n-1}$ over a range of electron density from 4×10^{12} to 4×10^{14} per cm^3 indicates the validity of the model, and the values of $K_{n,n-1}$ are in reasonable agreement with a recent theory of classical excitation cross sections. A square root dependence of this cross section on the excess energy is indicated, since the values of $K_{n,n-1}$ appear to be independent of temperature. It is then found that $Q_{2,3} = 9.3 \times \sqrt{E}$, $Q_{3,4} = 73 \times \sqrt{E}$, and $Q_{4,5} = 380 \times \sqrt{E}$, where $Q_{n,n+1}$ is the averaged excitation cross section from the levels with principal quantum number n to the levels with principal quantum number n + 1 in units 10^{-15} cm^3, and E is the excess energy in ev. These cross sections have an estimated error of about 30% in the threshold energy range to about 0.3 ev. (auth)

26669 (NASA-TN-D-1734) DISPERSION AND DAMPING OF LONGITUDINAL ELECTRON OSCILLATIONS IN THERMAL PLASMAS. James F. Morris (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). June 1963. 56p.

Approximate frequencies and damping factors computed for longitudinal electron oscillations in classical and quantum thermal plasmas are presented: effects of some major assumptions on the values of dispersion variables are discussed. These and some other simple, incidental characteristics of plasmas are tabulated for electron number densities from 10^3 to 10^{24} per cubic centimeter, temperatures from near the degeneracy level to 10^7°K, and wavelengths from about 1 to 10^5 times the Debye distance. (auth)

26670 (NASA-TR-R-172) GENERALIZED TREATMENT OF PLANE ELECTROMAGNETIC WAVES PASSING THROUGH AN ISOTROPIC INHOMOGENEOUS PLASMA SLAB AT ARBITRARY ANGLES OF INCIDENCE. Calvin T. Swift and John S. Evans (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). 1963. 43p.

The differential equations describing the passage of plane electromagnetic waves through a plane-parallel inhomogeneous plasma slab at an arbitrary angle of incidence are solved by numerical integration between appropriate boundary conditions. The methods used are described and a typical solution is discussed. (auth)

26671 (NP-12808) STEADY STATE THEORY OF A PLASMA, CONFINED BY COMBINED D. C. AND R. F. FIELDS. S. Kulinski (European Atomic Energy Community and Stichting Voor Fundamenteel Onderzoek der Materie. Instituut Voor Plasma-Fysica, Jutphaas, Netherlands). Feb. 1963. 96p.

The stationary state of a plasma column, confined in the radial direction by a steady longitudinal magnetic field B_0, and in the axial direction by r-f non-uniform electromagnetic fields, was considered. The energy and particle balances, and the equations for the electrostatic field caused by the charge separation, were established and numerical solutions were obtained. The calculations were done for a hydrogen plasma column 50 cm long and 2 cm in diameter. They show that for a steady magnetic field B_0 of the order of 3000 gauss, and an r-f electromagnetic field, with frequency 2.5 kMc and amplitude 10^6 v/m an almost fully ionized plasma can be obtained. The expected density is 10^{10} particles per cm^3, the temperature of the electrons is ≃50 ev and the temperature of the ions is $\simeq 0.2\ kT_e$. (auth)

26672 (NYO-10584) PLASMA PHYSICS. LECTURE NOTES, CHAPTER VI. OSCILLATIONS AND WAVES IN UNIFORM PLASMAS. George Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). 1962. Contract AT(30-1)-2813. 98p.

A self consistent treatment is applied to plasma phenomena in electromagnetic fields. Electrostatic oscillations, dispersion relations for cold electrons, non-linear plasma oscillations, transverse waves in an infinite plasma, electromagnetic waves in cold and hot magneto-plasmas, and instabilities in hot magneto plasmas are treated. (C.E.S.)

26673 (SIT-P84) EXPERIMENTAL INVESTIGATION OF TURBULENCE IN PLASMA IN A MAGNETIC FIELD. Annual Report. (Stevens Inst. of Tech., Hoboken, N. J.). Feb. 1963. Contract AT(30-1)-1921. 22p.

Work was initiated toward an understanding of high frequency resonances exhibited in a plasma column illuminated by plane electromagnetic radiation of wave length substantially greater than the radius of the column when the electric and propagation vector are both normal to the axis of the column. The resonances were excited by 3 and 10 cm microwaves in both free space scattering experiments and in wave guides. A bakable quartz discharge tube was constructed. A rotatable detection system consisting of a 20 db horn, rotatable wave guide joint, null bridge, and phase shifters was also constructed. Diagrams of the discharge tube and detection system were included. (C.E.S.)

26674 (SIT-P87) THE ROLE OF PLASMA VORTICES IN PLASMA TURBULENCE. Winston H. Bostick (Stevens Inst. of Tech., Hoboken, N. J.). Mar. 1963. Contracts AT(30-1)-1921 and AF19(604)-4086. 18p.

The generation mechanisms of plasma vortices in geometries such as those occurring in the coaxial accelerator, in the conical θ-pinch, and when a plasma from a field-free region encounters a magnetic field which is perpendicular to the direction of propagation of the plasma are discussed. When the vortices are numerous and random, they are called turbulence. (auth)

26675 (UCRL-7107) HYDROMAGNETIC INSTABILITIES DUE TO FINITE RESISTIVITY. Harold P. Furth (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 22, 1963. Contract W-7405-eng-48. 20p.

The theory of hydromagnetic instabilities due to finite resistivity is reviewed in simple terms. A variational principle is derived from which instability growth rates can be estimated. (auth)

26676 (UCRL-7253) AN INTERACTION BETWEEN A PLASMA AND A TRAVELING MAGNETIC DISTURBANCE. Daryl D. Reagan (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 25, 1963. Contract W-7405-eng-48. 11p.

A traveling wave disturbance can move in the direction parallel to an axial magnetic field in a hot cylindrical plasma, producing sinusoidal compression and expansion.

Approximate equations are derived, that govern the perpendicular and parallel temperatures, density, and axial drift speeds of the electrons and ions, and the induced axial electric field in such a disturbed plasma. The treatment is restricted to disturbance frequencies that are well below the cyclotron and plasma frequencies. Collision terms involving electron-electron, electron-ion, and ion-ion encounters are evaluated. It is shown that the plasma mass motion can have both longitudinal and transverse components. (auth)

26677 A HIGHLY IONIZED PULSED P.I.G. REFLEX DISCHARGE. R. Geller and J. Hosea (Stanford Univ., Calif.). Appl. Phys. Letters, 2: 215-17(June 1, 1963).

Design and operation of the PIPER machine that permits observations of plasma behavior in magnetic fields from about 100 to 2000 gauss and permits study of the transition from classical diffusion to anomalous diffusion are discussed. Current, density, and voltage measurements made in the pulsed PIG reflex discharge machine that can produce almost fully ionized plasma are included. (D.C.W.)

26678 A PULSED TOROIDAL P.I.G. DISCHARGE. R. Geller (Stanford Univ., Calif.). Appl. Phys. Letters, 2: 218-19(June 1, 1963).

Design and operation of a pulsed toroidal PIG discharge that creates an endless arc by allowing electrons to gyrate in loops is described. The magnetic field is variable up to 600 gauss with a planned capability of 2000 gauss, and the pressure is variable from 10^{-6} to 10^{-2} torr. Plasma densities above 1.6×10^{13} have been confirmed by interferometric measurements on Ar and H plasmas. (D.C.W.)

26679 INVESTIGATION OF THE ELECTROMAGNETIC RADIATION FROM A LINEAR HIGH-CURRENT DISCHARGE PLASMA. V. A. Suprunenko, Ya. B. Fainberg, V. T. Tolok, E. A. Sukhomlin, N. I. Reva, P. Ya, Burchenko, N. I. Rudnev, and E. D. Volkov. At. Energ. (USSR), 14: 349-52(Apr. 1963). (In Russian)

The electromagnetic radiation generated by a high-current discharge plasma was investigated under conditions involving a large flux of "run-away" electrons which caused beam instabilities. In view of the previously observed longitudinal oscillation generated by the passage of an electric current, an attempt was made to establish a correlation between the run-away electron flux and the intensity of the radiation, with special attention concerning its coherent nature. The tests were carried out by means of a 10-cm diameter and 25-cm long alundum tube, filled with H_2 under a pressure of 10^{-2} mm of Hg, through which a 15-microfarad, 30 to 40 kv battery was discharged at a current of 100 kamp. The preliminary test results indicated that during the first 3 to 5 microseconds the high-current discharge creates a plasma pinch in which the magnetohydrodynamic instabilities have no time to develop. In subsequent tests the run-away electron current was recorded by a current collector, placed at a distance much larger than the mean free path of the thermal electrons in the gas, thus recording only the free electrons. The electric field of 100 to 500 v/cm was of the same order of magnitude as the critical field at which all electrons become run-away electrons. It was found that there is a critical current in the plasma, below which the electromagnetic radiation suddenly disappears. The run-away electron field was found to increase uniformly with the electric field up to the critical value, at which it drops. (TTT)

26680 THE PASSAGE OF A PLASMOID THROUGH AN ADIABATIC TRAP WITH MAGNETIC MIRRORS. N. N. Brevnov and A. I. Matulis. At. Energ. (USSR), 14: 354-8 (Apr. 1963). (In Russian)

Containment of a plasma in a magnetic mirror trap requires specific injection conditions while maintaining the plasma in the trap at a sufficiently high density, temperature, and degree of ionization. In order to determine these conditions, the behavior of plasmoids accelerated in a plasma injector was studied during their movement alongside the axis of the adiabatic trap "Ogrenok," provided with magnetic mirrors. During the experiments the constant magnetic field was varied from 0 to 6600 oersted, using a coaxial plasma injector for accelerating the plasmoid, in 2 bunches with velocities of 10^7 and 2×10^6 cm/sec. During their passage through the first magnetic mirror, both bunches were decomposed into jets. The first plasmoid escaped from the 350-cm long trap in about 90 microseconds; the luminescence of the trap continued for 700 microseconds. The data indicated that plasmoids with a velocity of 10^7 m/sec are able to pass through several meters in a field of several thousands of oersted while retaining their compact shape; slower-moving plasmoids are decomposed into separate jets because of the prevailing instabilities and behave like poorly conducting plasmas. (TTT)

26681 EFFECTS OF THE TIME-OF-FLIGHT OF ELECTRONS IN A HIGH FREQUENCY PROBE. Yoshi H. Ichikawa (Univ. of Nihon, Tokyo). Compt. Rend., 256: 3434-7(Apr. 17, 1963). (In French)

The characteristics of the rectified current in the region of low and high frequencies of the resonance probe were formulated by taking into consideration the effects of the time of flight of the electrons. (tr-auth)

26682 ACCELERATION OF SHOCK-WAVE IN PLASMA. J. Kracik (Physical Inst., Podebrady, Czechoslovakia). Czech. J. Phys., 13: 246-52(1963). (In English)

The velocity of propagation of electroacoustic waves is decisive for the production of shock waves in plasma and for its expansion into vacuum. The relations derived for this velocity from the equations of a hydrodynamical description agree with the experimental results in the literature. The motion of strong shock waves in plasma is defined by the motion of the plasma immediately beyond the front of the wave. In order to accelerate this cluster of plasma either the method of discharge motion between two parallel electrodes or the method of cluster motion in the magnetic field of accelerating coils can be used. The disturbance of the quasi-neutrality of the wave front can also be assumed. The first method is sufficiently well known. For the second method an expression was derived for the acceleration as a function of the field configuration. The third method could only be discussed due to a lack of experimental material. (auth)

26683 NEAR-BY EQUILIBRIA AND STABILITY OF CYLINDRICAL PLASMA. M. Cotsaftis, M. Mercier, and P. H. Rebut (EURATOM-CEA, Fontenay-aux-Roses, France). J. Nucl. Energy, Pt. C, 5: 1-6(Jan.-Feb. 1963). (In French)

A stability criterion, independent of Ohm's law is obtained for cylindrical plasmas by means of the study of near-by equilibria. This criterion is the same as that given by the energy principle except in some particular cases. These cases often lead to new instabilities. (auth)

26684 PHYSICS OF ELECTRON AND PLASMA STREAMS. E. R. Harrison (Rutherford High Energy Lab., Didcot, Berks, Eng.). J. Nucl. Energy, Pt. C, 5: 23-30 (Jan.-Feb. 1963). (In English)

The physical properties of electron and plasma streams

are discussed and classified in terms of three general dimensionless parameters. For electrons these parameters are: α_e, the ratio of stream kinetic energy to the thermal energy of transverse motions; β_e, the ratio of the electron pressure to the magnetic pressure produced by the longitudinal electron current; and ν_e, the line density multiplied by the classical electron radius. These three parameters have the quite general relation of $\alpha_e\beta_e\nu_e \simeq 1$. This general relation is used as the basis of an elementary and a descriptive study of electron beams and plasma streams. (auth)

26685 TURBULENT PLASMA IN A STRONG MAGNETIC FIELD. B. B. Kadomtsev ([Inst. of Atomic Energy,] Academy of Sciences, Moscow). J. Nucl. Energy, Pt. C, 5: 31-6(Jan.-Feb. 1963). (In English) (Translated from Russian by J. B. Sykes).

A brief survey of various problems recently elucidated in connection with turbulent motion of a plasma in a strong magnetic field is given. The turbulence in the plasma of the positive column of a glow discharge, the drift instability of plasma, turbulent convection of a rarefied plasma in a longitudinal current, dynamics of a weakly turbulent plasma, and electrical conduction and diffusion of an inhomogeneous plasma are considered. (C.E.S.)

26686 CALCULATIONS AND MEASUREMENTS ON AN X-BAND MICROWAVE INTERFEROMETER. A. J. Postma and J. C. Terlouw (FOM-Instituut voor Plasma-Fysica, Rijnhuizen, Jutphaas, Holland). J. Nucl. Energy, Pt. C, 5: 37-42(Jan.-Feb. 1963). (In English)

A microwave interferometer that is suitable for the measurement of the electron density in the positive column of a gas discharge is described. The discharge tube is placed in the waveguide structure. The construction of the interferometer is such that reflections of the e.m. signal on the plasma boundary are very small. The propagation constant was solved numerically from the wave equation, under the assumption that the electron density distribution over the cross section of the discharge tube has the form of a parabola. The influence of the glass wall of the discharge tube was taken into account. Measurements are in good agreement with work of others. (auth)

26687 COLLISIONLESS SHOCK WAVES IN A PLASMA IN A WEAK MAGNETIC FIELD. S. S. Moiseev and R. Z. Sagdeev (Inst. of Nuclear Physics, Academy of Sciences, Novosibirsk, USSR). J. Nucl. Energy, Pt. C, 5: 43-7(Jan.-Feb. 1963). (In English). (Translated from Russian by J. B. Sykes).

The relation is investigated between laminar and turbulent theories of the structure of a collisionless shock wave. For $p_e \gg p_i$, where p_i, p_e are the ion and electron pressures, a laminar structure of the shock wave may be constructed in terms of the solitary wave with thickness of the order of the Debye length. When $p_i \gtrsim p_e$ the principal part within the shock front is played by scattering of ions by small-scale field fluctuations that result from anisotropic instability. The thickness magnitude of the front is given. (auth)

26688 RADIATION TRANSFER IN A PLASMA WITH ELECTRON COLLISIONS. A. G. Hearn (United Kingdom Atomic Energy Authority, Culham, Berks, Eng.). J. Quant. Spectry. Radiative Transfer, 3: 159-62(Apr.-June 1963).

An equilibrium solution for the populations of excited levels in optically thin plasmas was calculated for a simplified atomic model of two levels. Four processes of electron transfer between the levels are included: electron excitation and de-excitation, spontaneous emission, and photo-excitation. The source functions and intensities are expressed as fractions of these under black body conditions. (D.L.C.)

26689 SOME QUESTIONS ON THE TOPOLOGY OF THE MAGNETIC FIELD. G. V. Skornyakov (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Fusion, 2: 121-4 (Dec. 1962). (In Russian)

General requirements are investigated for the topology of the field of a magnetic trap that is to establish thermal insulation of a plasma for long periods. The topologic structure of magnetic fields whose lines of force do not leave the boundaries of a finite volume is studied. The necessary condition for the existence of such a field is the presence, among its integral surfaces, of a smooth surface, homeomorphic to a torus, on which the magnetic field does not vanish at any point. In principle such fields can be obtained by means of a superconductor that bounds the toroidal cavity. The stability of the magnetic-field topology was investigated with respect to small perturbations. The necessary and sufficient condition for the stability of the topology is that the rotation number change in the layer of toroidal magnetic surfaces. A method is proposed for establishing a trap with a magnetic-field strength increasing toward the periphery. Details of a mathematical character were omitted. (auth)

26690 ON THE THEORY OF PROCESSES IN PLASMA THAT PRODUCE MIGRATION ACROSS A MAGNETIC FIELD. V. P. Silin (Lebedev Inst. of Physics, Moscow). Nucl. Fusion, 2: 125-9(Dec. 1962). (In Russian)

The theory of transfer phenomena by which a plasma migrates across a constant magnetic field is set forth. An important new feature is the inclusion of the interaction of plasma particles with longitudinal oscillations. It is shown that for sufficiently large ratios of electron to ion temperatures the effect of the interaction of particles with plasma oscillations leads to significant modification of the transfer coefficients. Conditions of applicability were revealed that, first, lead to the possibility of using perturbation theory by means of a parameter defining the magnitude of the interaction of plasma particles, second, lead to the bonding of the plasma with not-too-large magnetic fields so that they have practically no effect on the interaction formula, and third, lead to the ordinary condition of expansion in inverse powers of the magnetic field corresponding to the fact that the frequency of collisions is small in comparison with the Larmor frequency. (auth)

26691 HYDROMAGNETIC STABILITY OF A TOROIDAL PLASMA: VARIATIONAL STUDY OF THE INTEGRAL OF ENERGY. M. Bineau (Max-Planck-Institut fur Physik und Astrophysik, Munich). Nucl. Fusion, 2: 130-47(Dec. 1962). (In French)

The energy principle is taken as the basis for studying toroidal equilibrium; this raises the problem of the minimum of the energy integral. This problem is studied in accordance with the methods of the theory of the calculus of variations. The stability can be deduced from the behavior of solutions of an integro-differential system. The existence of a certain admissible solution—that is, one having a physical meaning—of zero value on two magnetic surfaces, is a necessary and sufficient condition for instability. (auth)

26692 CONFINEMENT OF A DENSE PLASMA BY A STATIC MAGNETIC AND STATIONARY ELECTROMAGNETIC FIELDS. Tĕrenzio Consoli, René Le Gardeur, and Lucien Slama (CEN, Saclay, France). Nucl. Fusion, 2: 148-54(Dec. 1962). (In French)

In the device described is a cavity containing a plasma

that is pre-formed and pre-heated in order to fix the mode, to facilitate the tuning of the oscillators exciting the cavity and to permit investigation of the reduction in frequency resulting from the evolution of the plasma. The initial plasma in the form of a spindle is strongly ionized (>50%) and of high density (>10^{13} e/cm^3). The spherical cavity, in the absence of plasma, is resonant at ~1130 MHz in the mode H_{101}. The depth of penetration (<2 mm) is a small fraction of the diameter of the plasma (~6 cm). The plasma behaves like a metallic conductor. Use of two H_{101} modes perpendicular to one another in space gives a confinement with no gap. The initial plasma is created by means of a pulsed reflex discharge (pulse length ~100 μsec) of which the cavity constitutes the interanode section. Controllable densities from 10^{12} to 10^{14} e/cm^3 are readily obtained. The portion of the discharge situated outside the cavity allows the determination of the parameters of the discharge. A system of eight pulsed auto-oscillators is coupled to the cavity and regulated in such a manner that oscillation frequency will be near the theoretical resonance frequency of the cavity containing the plasma. In this way the radiation pressure is maintained in spite of the variations in diameter and form of the plasma. The power delivered increases progressively as the resistivity of the plasma diminishes. The couplings of the oscillators to the cavity are capable of being oriented in an arbitrary manner. One can thus either fix the axis of the mode or choose an operational regime with one or two modes. Windows are provided for the application of various diagnostic techniques. (auth)

26693 INFLUENCE OF THE INITIAL CONDITIONS ON THE ADIABATIC COMPRESSION OF A COLUMN OF PLASMA. Térenzio Consoli, Richard Geller, and René Le Gardeur (CEN, Saclay, France). Nucl. Fusion, 155-61 (Dec. 1962). (In French)

A plasma created by a pulsed reflex discharge and preheated by oscillating electromagnetic fields is subjected to adiabatic compression. The ionic and electronic temperatures are of the order of several ev. The electron density is 10^{14} cm^{-3}. The magnetic field trapped in the discharge is uniform, reversible, and well determined before compression. The electronic and ionic temperatures, density of neutrals, electron density, level of ionization, magnetic field compression and mirror ratio can be varied at will. A battery of 28 capacitors of 2.5 μf and 25 kv enables the production of a 70-kgauss magnetic field in a volume of 280 cm^3. Rise time is 1.5 μsec. A short circuit permits a field duration of 100 μsec. The magnetic compression compares favorably with theoretical conditions. (C.E.S.)

26694 DIELECTRIC PROPERTIES OF INHOMOGENEOUS PLASMA. A. B. Mikhailovskii (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 2: 162-76(Dec. 1962). (In Russian)

An expression is derived for the dielectric tensor of an inhomogeneous plasma contained by a constant magnetic field. In calculating the tensor, attention is directed mainly to a calculation of the effects associated with drift movements of the plasma particles, effects that are important for waves with a very small phase velocity. It is suggested that a calculation of the tensor, once and for all, would be highly useful for calculating the oscillations and the stability of an inhomogeneous plasma as one would then only have to solve Maxwell's equations; a solution of the charge-movement equations for each separate case would be avoided. The dielectric tensor is calculated for a plasma in plane geometry; in other words, the lines of force of the magnetic field are assumed to be straight and parallel to one another. An imaginary gravitational field is introduced in order to obtain a qualitative evaluation of the curvature of the lines of force. It is assumed that the equilibrium-value gradients and the gravitational field are sufficiently small and perpendicular to the magnetic field. The oscillation frequency is considered to be large compared with particle-collision frequency. Vlasov's kinetic equation is used in deriving the expression for the tensor. The equilibrium state of each type of plasma charge is characterized by an arbitrary function of the centers of Larmor circles. Wave frequency is assumed to be arbitrary in relation to the cyclotron frequency of all the particles considered, and, similarly, the wavelength is considered arbitrary in relation to the Larmor radius of the particles. The direction of the wave vector is taken to be arbitrary in relation to the direction of the magnetic field and the inhomogeneity of the plasma. Both the macroscopic drift speeds of the $c \nabla p/enH$ type and the microscopic drifts of individual particles are taken into account. Calculation of the diamagnetic drift, in particular, which is related to the magnetic-field gradient, makes it possible to deal with problems of plasma oscillation not only for low-pressure systems but for high-pressure systems as well. The case of a low-pressure plasma without equilibrium electrical and gravitational fields—that is, a system in which only the effects of Larmor drift are important—is considered in detail. For this case a simpler expression was derived for the dielectric tensor as well as an equation describing vortex-free oscillations of arbitrary frequency. Special attention is given to low-frequency waves directed almost perpendicularly to the magnetic field. Dispersion equations were derived for the Alfvén and ion-acoustic waves modified by drift movements, in an inhomogeneous plasma. These waves are unstable and their buildup may endanger the success of experiments in containing plasma. (auth)

26695 EXCITATION OF ELECTROMAGNETIC WAVES ACROSS A BEAM OF CHARGED PLASMA PARTICLES. V. G. Makhankov and A. A. Rukhadze (Lebedev Inst. of Physics, Moscow). Nucl. Fusion, 2: 177-82(Dec. 1962). (In Russian)

Excitation of electromagnetic waves propagating across a beam of charged plasma particles was investigated and thermal motion taken into account. The excitation of electromagnetic waves is shown to occur both at directed beam velocities exceeding thermal particle velocities and at velocities smaller than the thermal velocities of plasma particles. With a slow beam whose directed velocity is smaller than any kind of thermal particle velocity in the system, excitation of electromagnetic waves does not occur. With an external magnetic field, excitation of waves propagating across a magnetic field occurs at $u^2 > v_{A1}^2 + v_{A2}^2$, where v_{A1} and v_{A2} are the Alfvén velocities in the beam and in the quiescent plasma, respectively. (auth)

26696 BOUNDARY EFFECTS IN VISCOUS ROTATING PLASMAS. Wulf B. Kunkel, William R. Baker, Alexander Bratenahl, and Klaus Halbach (Univ. of California, Berkeley). Phys. Fluids, 6: 699-708(May 1963). (UCRL-10399 (Rev.)).

Current continuity and viscous drag at the boundaries in rotating-plasma experiments is discussed. A hypothetical model having a steady state with axial symmetry is particularly emphasized; it is shown that the discharge impedance derived from this model does not agree with many observations. The "Homopolar III" experiment in which the flux surfaces were strongly convex and parallel to the toroidal-shaped electrodes is described. In this way, friction at the insulators was reduced. But the structure

of the discharge deviated drastically from axial symmetry near the outer surface. Several studies led to the conclusion that the flow pattern probably involved secondary flows. It was also found that the rotational speed could not be raised above a few cm/μsec because the insulators failed in spite of the special design of the experiment. (auth)

26697 STREAMING OF A PLASMA THROUGH A MAGNETIC DIPOLE FIELD. Erik T. Karlson (AB Atomenergi, Stockholm). Phys. Fluids, 6: 708-22(May 1963).

The two-dimensional motion of a plasma in an inhomogeneous magnetic field with circular symmetry and a homogeneous external field under the influence of an electric field was studied previously. The influence of space charges was taken into account. However, the treatment was generally valid only when no forbidden regions for the particles exist. When the inhomogeneity is strong enough, such forbidden regions will arise. The treatment is now generalized, so that it is valid for this case also. A discussion is given of the possibility to explain geomagnetic storms and auroral phenomena within the framework of the present theory. (auth)

26698 THEORY OF FORBIDDEN ZONES IN THE FLOW OF A MAGNETIZED PLASMA. J. C. Helmer (Royal Inst. of Tech., Stockholm). Phys. Fluids, 6: 723-8 (May 1963).

The theories of Alfvén and Karlson on the two dimensional flow of a magnetized plasma are discussed. An analog mathematical model is introduced to clarify the various features of Karlson's exact theory of forbidden zones. It is shown that the boundary of the forbidden zone is a contour of constant magnetic field strength. Karlson's theory is generalized to include an arbitrary energy distribution in the plasma, and it is shown that the size of the forbidden zone is not unique. The physical processes that give rise to charge separation and the creation of high electric fields in the plasma are examined in detail, and an elementary derivation of the appropriate Poisson's equation is given. (auth)

26699 PLASMA INSTABILITIES INDUCED BY RESISTIVITY GRADIENTS. L. C. Woods (Balliol Coll., Oxford and Culham Lab., Berks, Eng.). Phys. Fluids, 6: 729-36(May 1963).

Plasma instabilities arising from a radial gradient in resistivity are investigated for incompressible motions of a magnetized, cylindrical plasma. Hydromagnetic waves moving along an axial magnetic field B_0 are normally damped by resistivity $1/\sigma$. However if $1/\sigma$ varies with radial distance r, it is found that the resistive damping ϵ is reduced by a term proportional to $d(1/\sigma)/dr = (1/\sigma)'$. If in addition there is a small axial current j_0, ϵ is further reduced by a term $\propto \delta(1/\sigma)'$, where $\delta = \mu j_0/B_0$. For certain waves the direct damping is negligible, whereas the term involving $\delta(1/\sigma)'$ is not, with the consequence that these waves are unstable. These unstable hydromagnetic waves occur when either the ion-cyclotron frequency is much less than $v_A(k^2 + k_c^2)^{1/2}$, where v_A is the Alfvén speed, and k, k_c are the axial and radial wavenumbers, or when k is much less than k_c, i.e., when the wavelength is much greater than the radius of the cylinder. Explicit formulas are given for the growth rates of the unstable waves. Kadomtsev's current-convective instabilities due to temperature perturbations are also obtained which thus also provides an extension of his work on rectangular plasma slabs to cylindrical plasmas. (auth)

26700 MAGNETO-ACOUSTIC OSCILLATIONS IN A CYLINDRICAL PLASMA COLUMN. L. Lindberg and L. Danielson (Royal Inst. of Tech., Stockholm). Phys. Fluids, 6: 736-44(May 1963).

A radial low frequency oscillation in a cylindrical plasma column located in a homogeneous axial magnetic field was observed. A theory for radial magneto-acoustic waves in a plasma of finite conductivity is developed and applied to the experiment. The temperature and conductivity of the plasma can be determined from the frequency and damping of the waves. (auth)

26701 PERTURBATIONS OF NONLINEAR TRAVELING WAVES IN A COLD PLASMA. E. Atlee Jackson (Univ. of Illinois, Urbana). Phys. Fluids, 6: 753-4(May 1963).

A simplified approach is used to determine the eigenmodes for the perturbations of self-consistent nonlinear travelling waves in a plasma. Degeneracy, frequency, and periodicity of the eigenmodes are examined. (D.C.W.)

26702 ONE-DIMENSIONAL MAGNETOGASDYNAMIC FLOW WITH WALL FRICTION. Ching-shi Liu and Ali Bulent Cambel (Northwestern Univ., Evanston, Ill.). Phys. Fluids, 6: 792-6(June 1963).

The case of one-dimensional magnetogasdynamic flow under the influence of wall friction is investigated. In particular, the case of an infinitely conducting, compressible plasma is studied when the flow direction and the direction of the magnetic field are at right angles to one another. It is shown that all flow variables can be expressed as functions of the ratio of the local flow velocity to the Alfvén velocity. It is shown that the flow has a variety of regimes delineated by specific singularities and extremities. A typical magnetogasdynamic Fanno flow chart is presented and it is noted that the flow differs markedly from that encountered in classical gasdynamics. (auth)

26703 ELECTRICAL CONDUCTIVITIES OF SEEDED FLAME PLASMAS IN STRONG ELECTRIC FIELDS. M. Lapp and J. A. Rich (General Electric Research Lab., Schenectady, N. Y.). Phys. Fluids, 6: 806-16(June 1963).

The effect of an applied electric field on the electrical conductivity of potassium-seeded acetylene-air and hydrogen–oxygen flame plasmas at atmospheric pressure was explored experimentally. These flames, of interest for magnetohydrodynamic studies, were produced on a Meker-type burner designed to give a seeded cylindrical core surrounded by an unseeded shield flame. The flow system, unconfined by walls, was particularly advantageous for conductivity measurements. The voltage gradient was determined by means of a floating double probe. The effective flame diameter, seed partial pressure and gas temperature were determined spectroscopically. Good agreement between measured and calculated conductivities was obtained for low current densities. The enhancement of the conductivity observed for increasing current density can be accounted for on the basis of Joule heating of the gas in the case of C_2H_2/air/K. No simple explanation for the enhancement in the case of H_2/O_2/K was found. (auth)

26704 NEW APPROACH TO IRREVERSIBLE TRANSPORT PHENOMENA IN PLASMA DYNAMICS. P. Résibois (Université Libre, Brussels). Phys. Fluids, 6: 817-24 (June 1963).

A factorization theorem is demonstrated for special types of contributions to the time-dependent collision operator $G_{00}(\tau)$ that plays a central role in the classical

master equation derived by I. Prigogine and P. Résibois; this theorem expresses the mutual independence of two subgroups of particles when these groups are noninteracting with each other during a given time interval (τ_i, τ_j) of the collision process. The theorem is applied to rederive in a very direct way the kinetic equation of an homogeneous stable plasma, obtained first by R. Balescu. Other possible applications of the method are also discussed. (auth)

26705 VARIATIONAL TECHNIQUE FOR DETERMINING DISPERSION RELATIONS IN PLASMA SYSTEMS. E. M. Barston (Stanford Univ., Calif.). Phys. Fluids, 6: 828-33(June 1963).

Sturrock's variational principle is particularly well suited to the study of small-amplitude disturbances of plasma systems and is formulated in a sufficiently general manner so as to be applicable to relativistic as well as nonrelativistic multistream problems. The use of this variational principle is shown to be effective in approximating dispersion relations. To this end the variational procedure is applied to two simple plasma problems that admit of exact solution. It is found that a first-order error in the trial functions leads to only a second-order error in the dispersion relation—a behavior typical of variational procedures and that renders them so useful. (auth)

26706 HIGH-FREQUENCY PLASMA CONDUCTIVITY IN A MAGNETIC FIELD. Carl Oberman (Princeton Univ., N. J.) and Fred Shure. Phys. Fluids, 6: 834-8(June 1963).

The rigorous expression for the classical high-frequency conductivity of a fully ionized plasma was obtained earlier through a joint solution, in the plasma limit, of the first two members of the B-B-G-K-Y hierarchy when both are able to change on the same time scale. That treatment is now extended to include the presence of a uniform magnetic field. Through the use of a Fourier–Bessel transformation, the equation for the pair correlation function is rendered formally identical to that of the no magnetic field case. (auth)

26707 BOUND ON THE ENERGY AVAILABLE FROM A PLASMA. Clifford S. Gardner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 6: 839-40(June 1963).

The motion of an ideal collisionless plasma subject to periodic boundary conditions, with velocity distribution given initially, is studied. The minimum value that the kinetic energy can subsequently attain is determined, on the assumption that the system is subject only to the constraint that phase-space volume is conserved. (auth)

26708 EXPERIMENTAL TRAJECTORY ANALYSIS OF CHARGED PARTICLES IN A CUSPED GEOMETRY. James Sinnis and George Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Fluids, 6: 841-5(June 1963).

Electrons are injected axially from an external source into a cusp field. For the particles to be transmitted through the cusp they must be injected inside a loss disk of radius $\rho_{critical} = (mv)/(qB_0)$. At larger values of injection radius the depth of penetration beyond the median plane is measured and is in agreement with the maximum penetration depth predicted by the theory. The question of trapping is investigated and no long time confinement is obtained. The maximum number of reflections observed inside the cusp region is five. (auth)

26709 TOROIDAL DISCHARGE EXPERIMENTS WITH RAPID PROGRAMMING. T. Ohkawa, H. K. Forsen, A. A. Schupp, Jr., and D. W. Kerst (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 6: 846-57(June 1963).

Five plasma configurations were studied in a fast-programmed toroidal discharge device where magnetic field errors were minimized. The effects of the programming on the plasma were examined with magnetic probes, a Kerr cell camera, and a monochromator. Without programming, the plasma developed a well-defined kink that corresponded to the worst mode of the instability predicted by hydromagnetic theory. By programming, the plasma lasted for 10 to 15 μsec at ion temperatures up to 130 ev and with densities up to 3×10^{16} cm^{-3}. (auth)

26710 ANALYTIC SOLUTION OF THE THERMALIZATION OF A FAST ION IN A PLASMA. Francis H. Ree and Ray E. Kidder (Univ. of California, Livermore). Phys. Fluids, 6: 857-64(June 1963). (UCRL-7025)

The coefficients of friction and dispersion that appear in the Fokker–Planck equation describing the thermalization of a test ion in a plasma are approximated. The approximation is valid when the speed of the test ion is less than the average speed of the plasma electrons, but large enough that the plasma electrons interact more strongly with the test ion than do the plasma ions. The resulting Fokker–Planck equation is solved to obtain an exact analytic expression for the time-dependent energy distribution function of the test ion. This distribution function is used to examine in detail the nature of the approach to equilibrium. (auth)

26711 PLASMA CONTAINMENT IN THE THETA PINCH. T. S. Green (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Phys. Fluids, 6: 864-74(June 1963).

An experimental investigation of the containment time of plasma in a theta pinch is described. Observations of changes in the plasma diamagnetism were made, analysis of which leads to a determination of the field trapping conditions in the plasma and of the variations in line density of the plasma that take place during a discharge. The results show that in parallel field discharges the containment time of the plasma depends on the flux trapped within the plasma, in agreement with theoretical predictions. In particular, the containment time increases as the flux approaches zero. In reversed field discharges the plasma containment is limited by an axial contraction instability, which is slower the lower the amount of reversed trapped flux. At very low values of this flux, the plasma appears to stay contained and stable in a closed reversed field configuration for the period of observation. (auth)

26712 EFFECTS OF ADDED HEXAPOLE MAGNETIC FIELDS AND PREIONIZATION IN THETA PINCH EXPERIMENTS. E. M. Little and W. E. Quinn (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 6: 875-83(June 1963).

A hexapole magnetic field was superimposed on the fast magnetic mirror compression field of the Scylla III θ pinch in an attempt to stabilize an observed plasma instability. The instability is of the flute type with a superimposed rotation. The effect of the hexapole field on the plasma stability was studied with streak camera photography and through observation of the neutron emissions. Under certain conditions the hexapole stabilizing field has an observable effect on the instability. Its main effect is to symmetrize the rotation about the axis of the compression coil and to produce a delay in the onset of the instability. There is at most a small effect tending to symmetrize the time distribution of neutron emission and to

increase the neutron yield. An ionized deuterium plasma is produced by a fast, low energy capacitor bank coupled directly to the single-turn compression coil of the Scylla III device. The afterglow of this preionization discharge, uniformly permeated by a magnetic bias field B_0, forms the initial condition for the application of the main magnetic compression field. The effect of the main compression field on the preionized plasma depends strongly on the B_0 that exists in the plasma. (auth)

26713 EFFECT OF FINITE RESISTIVITY ON GRAVITATIONAL INSTABILITY. M. Sato and I. Kawakami (Nihon Univ., Tokyo). Phys. Fluids, 6: 885-6(June 1963).

It is shown that the finite resistivity of plasma has a stabilizing effect in a configuration in which a plasma is supported by a magnetic field against a gravitational force. The finite resistivity allows a discharge current to flow across magnetic lines of force, and the instability-driving charge separation due to the gravitational drift is reduced. (C.E.S.)

26714 COHERENCE EFFECTS ON BREMSSTRAHLUNG LOSSES FROM PLASMAS. B. Buti (Yerkes Observatory, Williams Bay, Wis.). Phys. Fluids, 6: 886-? (June 1963).

It is shown that the effect of coherence on bremsstrahlung radiation from plasma is negligible for a nonrelativistic plasma. (C.E.S.)

26715 EXCHANGE ENERGY OF AN ELECTRON GAS IN A PERIODIC POTENTIAL. Leonard Eyges (Massachusetts Inst. of Tech., Lexington). Phys. Rev., 130: 2218-23 (June 15, 1963).

General formulas for the exchange energy of an electron gas in a periodic potential, and for $E_{ex}(k)$, the exchange energy of a single electron as a function of k. The formulas are evaluated, with some approximations, for S-like bands; for $E_{ex}(k)$ is obtained $E_{ex}(k) = [E_{ex}(k)]_{free\ elect.} - (e^2k_0/\pi) \sum_{K_s \neq 0} n_s R^2(K_s) g\,[(K_s/k_0), (k/k_0)]$, where K_s is the magnitude of a reciprocal lattice vector, n_s is the number of vectors with that magnitude, $R(K_s)$ is a function which is derived from the wave functions of a single electron in the lattice and $g(K_s/k_0, k/k_0)$ is calculated. The main conclusion is that even if $R(K_s)$ derives from a wave function that is far from a plane wave, the function $g(K_s/k_0, k/k_0)$ drops off so quickly as a function of K_s that for many practical cases, essentially the only contribution to the exchange energy comes from the plane wave component corresponding to $K_s = 0$. Thus, the plane wave expression for the exchange energy has a larger range of validity than might appear at first sight. A numerical evaluation of the total exchange energy is carried out for sodium. (auth)

26716 HIGHER RANDOM-PHASE APPROXIMATIONS AND THE THEORY OF THE ELECTRON GAS. Giu Do Dang and Abraham Klein (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 130: 2572-79(June 15, 1963).

Using the example of the degenerate electron gas, it is shown how the operator equations of motion for a many-particle system may be exploited to generate systematically a sequence of nonperturbative approximations of which some version of the random phase approximation is the first. Some questions left unsettled by previous attempts in this direction are resolved by close attention to the structure of the spectrum of the system. The solution of the equations is carried only so far as to make contact with previously substantiated results. Finally, a rigorous proof is given that the plasmon frequency approaches the classical plasmon frequency in the long-wavelength limit. (auth)

26717 COLLISION DAMPING OF PLASMA OSCILLATIONS. [PART] I. David Gorman (Washington Univ., St. Louis) and David Montgomery. Phys. Rev., 131: 7-12 (July 1, 1963).

Collision damping of long-wavelength electrostatic oscillations in a high-temperature plasma is studied with the use of Guernsey's kinetic equation. A closed expression for $\gamma_C(k)$, the collision damping decrement, is derived that is exact to first order in the plasma parameter, k_D^3/n. (auth)

26718 INTERACTION OF ELECTROMAGNETIC WAVES WITH QUANTUM AND CLASSICAL PLASMAS. Amiram Ron (Princeton Univ., N. J.) and Narkis Tzoar. Phys. Rev., 131: 12-20(July 1, 1963).

A systematic study of the absorption of electromagnetic waves in a quantum plasma is given, for waves whose frequencies are high compared to the collision frequency and whose wavelengths are long compared to the Bohr radius. The treatment rests on the introduction of the temperature-dependent Green's function and Kubo's formula for the conductivity. An exact expression for the conductivity is obtained for a quantum plasma, which in its classical limit is in complete agreement with Dawson and Oberman, and with Oberman, Ron, and Dawson. The special case is treated of a quantum system of electrons in the presence of fixed ion scatterers. (auth)

26719 ZEEMAN-EFFECT MAGNETIC FIELD MEASUREMENT OF A HIGH-TEMPERATURE PLASMA. F. C. Jahoda, F. L. Ribe, and G. A. Sawyer (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 131: 24-9(July 1, 1963). (LADC-5509)

Distortions of magnetic field measurements caused by material probes in hot plasmas can be avoided by measuring the Zeeman splitting of impurity spectral lines. The problem of the line breadths being large compared to the magnetic field splitting is solved by using the opposite circular polarization characteristics of the symmetrically displaced Zeeman components in a longitudinal field. This, however, limits the technique to wavelengths longer than 2000 Å, where there is a scarcity of intense allowed transitions from the highly ionized species that originate in the hot plasma. Successful measurements were made on the Scylla I theta pinch device. These indicate approximately zero magnetic field in the hot plasma and set a lower limit of 79% on the ratio of plasma to magnetic pressure. (auth)

26720 COOPERATIVE OSCILLATIONS IN A HIGH-TEMPERATURE PLASMA FORMED BY NEUTRAL ATOM INJECTION. C. C. Damm, J. H. Foote, A. H. Futch, and R. F. Post (Univ. of California, Livermore). Phys. Rev. Letters, 10: 323-6(Apr. 15, 1963).

New modes of stable oscillation observed in a low density (about 10^8 ions/cm^3) plasma formed by neutral atom injection into the magnetic mirror machine ALICE are reported. The oscillation frequencies range from 5 to 50 kc/sec; and two branches (one close to the calculated precession frequency of 20-kev ions and independent of plasma density, the other varying roughly linearly with plasma density) are noted. The observed modes agree tentatively with predictions of an extension of the theory of finite-orbit stabilization for low-density plasmas. (D.C.W.)

26721 PLASMA QUENCHING BY ELECTRONEGATIVE GAS SEEDING. G. G. Cloutier and A. I. Carswell (RCA Victor Co., Ltd., Montreal). Phys. Rev. Letters, 10: 327-9(Apr. 15, 1963).

The seeding of supersonic plasma streams with electronegative gases to reduce the system's electron density was investigated. Microwave back-scattering and double probe

measurements were made on argon plasma seeded with SF_6, air, and oxygen. Seeding with SF_6 reduced the electron density and the positive-ion density while air and oxygen seeding, even at much higher rates, produced negligible effects. (D.C.W.)

26722 THEORY OF TRANSVERSE WAVES IN VLASOV-PLASMAS. I. NO EXTERNAL FIELDS; ISOTROPIC EQUILIBRIUM. B. U. Felderhof (Rijksuniversiteit, Utrecht). Physica, 29: 293-316(Apr. 1963). (In English)

The theory of waves in spatially homogeneous Vlasov plasmas is studied, with emphasis on transverse electromagnetic waves. The basic equations are Vlasov's linearized equation and Maxwell's equations. These are solved jointly as an initial-value problem for arbitrary initial distribution function of the particles and arbitrary initial transverse electric and magnetic fields by means of a method of stationary solutions. From the asymptotic behavior in time of the general solution, the waves of physical importance, for which frequency and wave number are related by a dispersion equation, are obtained. The nonrelativistic equations are solved in detail and it is shown that the relativistic problem is essentially the same. It is also shown that for transverse waves the nonlinear problem may be solved by the same method if the magnetic force is neglected. (auth)

26723 THEORY OF TRANSVERSE WAVES IN VLASOV-PLASMAS. II. EXTERNAL MAGNETIC FIELD; ANISOTROPIC EQUILIBRIUM. B. U. Felderhof (Rijksuniversiteit, Utrecht). Physica, 29: 317-27(Apr. 1963). (In English)

The theory of transverse waves in homogeneous Vlasov plasmas is extended to the case where waves propagate in the direction of an external magnetic field B_0. Vlasov's linearized equation and Maxwell's equations are solved jointly as an initial-value problem, for general equilibrium distribution f_0 compatible with the presence of B_0. Anisotropy of f_0 can give rise to instabilities, which are taken into account in the eigensolution expansion. The waves of physical importance, for which frequency and wave number are related by a dispersion equation, are obtained from the asymptotic behavior in time of the general solution. The phase velocity of these waves is different for either right- or left-hand circular polarization. (auth)

26724 PLASMA BUNCH WITH VARIABLE MASS IN AN EXTERNAL MAGNETIC FIELD. A. K. Musin. Radiotekhn. i Elektron., 7: 1799-1808(Oct. 1962). (In Russian)

Variable-mass plasma bunch motion in an external magnetic field was studied. Formulas were derived and asymptotic approximations were developed for a quantitative analysis of bunch velocity and acceleration efficiency. Effects of velocity and magnetic field variations on acceleration and accelerator efficiency as functions of electrical parameters were investigated. (tr-auth)

26725 PLASMA DELAY IN MAGNETIC DIFFUSER. A. K. Musin, D. N. Novichkov, and K. N. Ul'yanov. Radiotekhn. i Elektron., 7: 2051-61(Dec. 1962). (In Russian)

Plasma converter characteristics were investigated, and an analysis was made of ionized gas flow in a magnetic diffuser with arbitrary and equipotential planes. The data on equipotential flow were used in calculating flow rate along the axis, temperature, density, gas pressure, and diffuser shape. (tr-auth)

26726 PLANE ELECTROMAGNETIC WAVE DIFFRACTION BY PLASMA CYLINDER. Yu. N. Dnestrovskii and D. P. Kostomarov (Moscow State Univ.). Radiotekhn. i Elektron., 8: 408-15(Mar. 1963). (In Russian)

Studies were made of plane electromagnetic wave diffraction by a plasma cylinder in a homogeneous external field parallel to the cylinder axis. The studies were confined to normal incidence with the electric vector polarized along the cylinder axis. On the basis of the universal solution for dielectric cylinder diffraction, the problem was reduced to an integral equation resolved by a succession of approximations, considering that the cylinder radius and wave length are considerably larger than the mean Larmor radius of electrons in the plasma. (tr-auth)

26727 STATIONARY DISTRIBUTION OF ION CONCENTRATION IN POSITIVE COLUMN PLASMA IN EXTERNAL NONUNIFORM HIGH-FREQUENCY FIELD. K. S. Golovanivskii and A. A. Kuzovnikov (Moscow State Univ.). Radiotekhn. i Elektron., 8: 622-9(Apr. 1963). (In Russian)

Spatial distribution of ions in a helium plasma positive-column disturbed by an external nonuniform high-frequency electric field was investigated. It was shown that the plasma was pushed from a high field into a weak field region. The concentration of ions at various points under various pressures and discharge currents was studied, and the effect was interpreted using the concept of high-frequency potential and electrostatic plasma polarization. (tr-auth)

26728 ELECTRIC CONDUCTANCE OF GASEOUS MIXTURES IN PLASMA STATE. O. A. Malkin. Radiotekhn. i Elektron., 8: 630-8(Apr. 1963). (In Russian)

A calculation method was developed for determining neutral and charged particle concentrations and conductivity coefficients for multicomponent gas mixtures in a plasmic state. Applications and limitations of various calculational methods and of the suggested method are analyzed. It is shown that the suggested method can be applied at 2000 to 3000 and up to 50000°K and at 0.1 to 1000 atm of pressure. (tr-auth)

26729 RECOMBINATION AND IONIZATION IN A STATIONARY HIGH-FREQUENCY DISCHARGE. H. Schlueter (Univ. of Texas, Austin). Z. Naturforsch., 18a: 439-46(Apr. 1963). (In German)

A cool hydrogen plasma in a steady-state r-f discharge in a static magnetic field was investigated spectroscopically. The recombination rate of this plasma was determined. The essential three-body recombinations were taken into account for levels of medium quantum number, where the inverse process, ionizations from excited levels, was considerably lowered. Measured population densities were used for the determination of the recombination rate. The considerations included the effects of energetic electrons, the presence of which, in addition to the bulk of cool electrons, was detected by probe measurements. Within the limits of error the ionization rate calculated for the energetic electrons agreed with the recombination rate of the cool electrons. (auth)

26730 ON DRIFT INSTABILITIES IN A COLLISIONLESS ELECTRON-PROTON PLASMA FROM THE POINT OF VIEW OF ENERGY ABSORPTION OF RESONANT PARTICLES. Asbjoern Kildal (Euratom-CEA, Fontenay-aux-Roses, France). Z. Naturforsch., 18a: 446-53(Apr. 1963). (In English)

A study was made of instabilities of electrostatic waves in a current-carrying collisionless plasma. As the underlying physical cause of the instabilities is the same as that of the Landau damping in an electron plasma, a detailed analysis of the latter is given. It is shown that the damping may be considered as being due to the fact that there are

more electrons in the phase-region where energy is absorbed by the particles from the field than in the phase-region where energy is given up to the field. The energy absorption A of the resonant particles, first in the absence of an external magnet field, B_0 and next when the wave is propagated under an arbitrary angle with respect to B_0 was evaluated. When $A > 0$, the wave is damped, and vice-versa. Without appeal to a dispersion equation, stability criteria can thus be found, dependent on the wave frequency and wave-vector. Some special cases were investigated and compared with the results of other authors where such results exist. As a consequence of the fact that some ions and electrons, the resonant particles, experience a constant electric field, these particles also experience a constant drift transverse to both E and B_0. This drift gives rise to a transverse current which is closely related to the damping or growing of the wave. An expression for this current averaged over one wave-length was found. (auth)

26731 ACCELERATION OF PLASMA. W. Bieger, H. Gresser, P. Noll, and H. Tuczek (Kernforschungsanlage, Jülich, Ger.). Z. Naturforsch., 18a: 453-9(Apr. 1963). (In German)

The generation and properties of plasmoids emitted by a conical electrodeless ring discharge were investigated. Image converter, magnetic probes, compensated magnetic loops, and a retarding field analyzer were used for diagnostics. There are two mechanisms of emission depending on the initial plasma density. At low densities, when the ions can be regarded as free particles, the acceleration is caused only by the electromagnetic field at the beginning of the discharge. At high densities, when the plasma behaves hydromagnetically, the emission mechanism is governed by trapped magnetic fields in the plasma. Under certain initial conditions a plasmoid with a trapped magnetic field is generated, which exists during a time of flight of the order of 10 μs. (auth)

26732 MEASUREMENT OF A MOVING PLASMA FRONT IN A T-TUBE WITH THE HELP OF 3-CM MICROWAVES. Horst Klingenberg and Elisabeth Meder. Z. Naturforsch., 18a: 459-65(Apr. 1963). (In German)

A 3-cm microwave apparatus served for measurements of the velocity of a plasma front in a hydromagnetic T-tube of glass. A cylindrical metallic hollow conductor was shoved over the glass tube. The frequency of electromagnetic waves reflected by the moving plasma front was shifted on account of the Doppler effect. They were superimposed on the waves of the original frequency. The resulting frequency difference recorded with an oscillograph was a measure of the velocity. For the microwave measurements, a pre-ionization of the gas in the T-tube was very disturbing, so that the velocity could be determined only at greater distances from the discharge gap. The detection of this pre-ionization was an interesting secondary result. (tr-auth)

26733 COVARIANT TREATMENT OF LINEARIZED MAGNETO-FLUID DYNAMICS. F. Winterberg (Case Inst. of Tech., Cleveland). Z. Naturforsch., 18a: 545-52(Apr. 1963). (In English)

A perfectly conducting, nonviscous fluid was assumed to be permeated by an inhomogeneous, time-independent magnetic field satisfying the magnetohydrostatic equation. This fluid is perturbed by hydromagnetic waves of small amplitude. The wave equation is expressed in a completely covariant form. This formulation allows a search for simplifying coordinate systems intrinsically adapted to the undisturbed field configuration. Hydromagnetic waves with the velocity vector satisfying the equation div v = 0, which are the natural generalization of Alfvén waves were especially investigated. It is shown that there are simplifying coordinate systems for the hydromagnetic wave equation. Especially it is shown that the solution of the Alfvén wave equation can always be reduced to the solution of an ordinary differential equation if in the equilibrium configuration the current is either perpendicular on the magnetic field line or zero. (auth)

26734 CONCERNING THE HYDRODYNAMIC APPROXIMATION FOR AN IONIZED GAS IN A STRONG ELECTRIC FIELD. V. M. Eleonskii and V. M. Zhdanov. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 1, 26-31(Jan.-Feb. 1963). (In Russian)

The solution of the problem concerning the behavior of an ionized gas in an external field leads to the analysis of simultaneous kinetic equations for the partial distribution function f(k). The approximation which arises from the existence of the generalized method of moments was examined. The distribution function of the ground state, f_0, was determined and the deviation from the ground state was investigated in the hydrodynamic approximation. The distribution function is expressed as a series in tensor polynomials of the base distribution, f_0. For the hydrodynamic approximation solution of the kinetic equations it is sufficient to retain only the first few members of the series. The moments form a closed system of equations in which the hydrodynamic variables enter in the relaxation times of these variables. For f_0 there exists an equation arising directly from the initial kinetic equation and from the chosen form of the infinite series for f(k). The system of equations for the moments and the equation for f_0 are self-consistent. Thus not only are the relaxation times determined by the ground state function, but the function, f_0, itself is expressed in terms of the hydrodynamic variables of the system. This type of approach to the solution of the kinetic equations can be used even when the distribution function of the ground state is not Maxwellian. (TTT)

26735 STRUCTURE OF A SHOCK WAVE IN A RAREFIED NONISOTHERMAL PLASMA. A. P. Kazantsev. Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 1, 32-7(Jan.-Feb. 1963). (In Russian)

The excitation of fluctuations in a shock wave front caused by beam instability was investigated. The problem was examined in a system of coordinates in which the profile of the shock wave does not change with time. In regions where the electric potential, ϕ, is substantially different from zero there exist captured electrons whose kinetic energy is less than $e\phi$ and whose average macroscopic velocity is zero. A beam of these captured electrons induces vibrations, low frequency in nature due to the slow velocity of the plasma flow. Calculations were made for a nonisothermal plasma in the absence of a magnetic field. In such a plasma it was found that slowly extinguishing sound vibrations can exist. Electrons that interact effectively with these vibrations possess little energy. Therefore, the dissipation energy connected with the transfer of the electron kinetic energy to the vibrational energy is also small. The calculation of the scattering of slow electrons by nonequilibrium fluctuations allows an uncertainty which is related to the choice of distribution functions for captured electrons that enter into the formation of the shock wave to be eliminated. The precise ranges of applicability of the results obtained in this investigation are discussed. (TTT)

26736 DISCHARGE TIME LAGS IN THE MAGNETIC FIELD. Stanley Thomas Nolan. Thesis, Gainesville, Fla., Univ. of Florida, 1962. 112p.

The effects of a transverse magnetic field on gaseous discharges in air for coaxial geometry has been investigated by measuring the formative time lags of breakdown as a function of the magnetic field and pressure. The pressures used were atmospheric and from 90 mm Hg to 1 mm Hg. Overvoltages up to 6% corresponding to time lags of the order of 0.5 μsec for a gap of 2 mm were used at pressures below 90 mm Hg. The results indicated a slight decrease in time lags when the cathode was contaminated for low-overvoltaged gaps where secondary mechanisms at the cathode are important. The time lags were independent of pressure for a constant overvoltage from 90 mm Hg to 20 mm Hg but increased for pressures below 20 mm Hg. At pressures below 5 mm Hg the time lags decreased rapidly for increased magnetic field followed by a rapid increase producing a "resonance" effect. The decrease in time lags for contaminated gaps is explained in terms of the Malter effect and the decrease of the grazing angle of positive ions on the cathode due to ions being curved by the magnetic field. The magnetic fields aid space-charge buildup, thus aiding the breakdown processes. The large decrease of time lags for increasing magnetic field at low pressures cannot be explained by changes in secondary emission alone and computations of the cyclotron frequency and collision frequency suggest a "resonance" effect where minimum time lags occur whenever cyclotron frequency is of the order of the collision frequency. (Dissertation Abstr.)

26737 THREE-PHASE GAS DISCHARGE EXPERIMENTS IN A MIRROR MAGNETIC FIELD. James Franklin Holt. Thesis, Columbus, Ohio, Ohio State Univ., 1962. 131p.

A brief treatment of a theory of ion cyclotron acceleration by moving magnetic fields and by 3-phase r-f currents, in an ambient containing d-c magnetic field, is presented. An expression for the induced electric field in a particular geometry of 3-phase currents is derived, and it is shown that there is a rotating induced electric field perpendicular to the d-c magnetic field. Experimental analysis of the electromagnetic fields of certain 3-phase coils and 3-phase electrodes by electron-beam deflections indicates that the theoretical electromagnetic-field interpretation is essentially correct. A 4-kilowatt, 1- or 3-phase, r-f power source was built to operate in conjunction with a 150-kw mirror magnet for plasma investigations. Phase and amplitude of the rotating fields of 3-phase coils and 3-phase electrodes can be adjusted; relative phases can be adjusted mechanically or electrically. Experiments with this apparatus indicate that there are significant differences in plasma behavior between single- and 3-phase r-f power. Observation of hydrogen and deuterium plasma was made by visible-light photography, GM counters, optical spectroscopy, and a phosphor screen. (Dissertation Abstr.)

26738 THE THEORY OF PLASMA WAVES. Thomas Howard Stix. Advanced Physics Monograph Series. New York, McGraw-Hill Book Co., Inc., 1962. 291p.

Information in plasma physics contained in the solutions to the linearized collision-free Boltzmann equations was presented. Topology of wave-normal surfaces, waves in cold uniform plasma, energy flow and accessibility, Kruskal-Schwarzchild solutions for bounded plasma, free and forced oscillations of cold cylindrical plasma, plasma models with discrete structure, longitudinal oscillations in plasma of continuous structure, derivation of theory for hot plasma in magnetic fields, applications of the equivalent dielectric tensor, and reflection and absorption of waves in hot homogeneous plasma were the main aspects included. (C.E.S.)

26739 AN INTRODUCTION TO WAVES, RAYS AND RADIATION IN PLASMA MEDIA. J. J. Brandstatter. New York, McGraw-Hill Book Co., Inc., 1963. 701p. $15.00.

Various factors that affect the propagation of waves, rays, and radiation in anisotropic plasma media were presented. The macroscopic and microscopic descriptions of plasma media and the electrodynamic and hydrodynamic coupling that can exist in the media were discussed. The propagation of electromagnetic and hydromagnetic waves, rays, and radiation in homogeneous and inhomogeneous dissipative anisotropic media was examined. The propagation of waves in a homogeneous ionic plasma in the presence of a magnetic field, energy considerations and electrodynamics of moving plasmas, and propagation phenomena based on the microscopic consideration of the Boltzmann equation were also included. (C.E.S.)

26740 TRAVELING WAVE PYROTRON. R. F. Post (to U. S. Atomic Energy Commission). U. S. Patent 3,093,569. June 11, 1963.

The invention relates to a pyrotron, i.e., magnetic mirror device, designed for continuous operation in producing a high-temperature fusion reaction plasma and for directly converting the plasma energy into electrical power. The device utilizes a system in which an axially symmetric magnetic field is produced and transports plasma through a first zone of progressively rising field intensity, a second reaction zone of slowly increasing intensity, and thenceforth through a third zone of progressively decreasing intensity wherein the plasma expands against the magnetic field thereby producing electrical current in magnetic field generating solenoids associated with said third zone. (AEC)

Shielding

Refer also to abstracts 24771 and 24772.

26741 (ORNL-TM-552) MATERIAL REQUIREMENTS FOR SHIELDING AGAINST SPACE RADIATIONS. Clayton D. Zerby (Oak Ridge National Lab., Tenn.). May 21, 1963. Contract [W-7405-eng-26]. 37p.

A brief but general discussion of the material requirements for shielding against space radiations is presented. Emphasis is placed on describing the salient features of the space radiation attenuation problem in order to deduce the materials that will most likely produce minimum-weight shields. The shielding characteristics of the materials are described as a function of atomic weights and no specific materials are referred to. In general it is found that the light atomic weight elements give the minimum-weight shields. (auth)

26742 THE BREMSSTRAHLUNG OF β PARTICLES AND ITS SHIELDING. V. S. Eliseev. At. Energ. (USSR), 14: 405-7(Apr. 1963). (In Russian)

The Plexiglass, Al, glass, and similar shields used for the protection of the operating personnel against β radiation are usually designed taking into account the bremsstrahlung generated by the absorption of β particles in the shield. For this reason, experiments were carried out for determining the effect of the shielding material on the energy of the maximum yield of the bremsstrahlung in the 0- to 200-kev range, using NaI(Tl) scintillation crystals and a photomultiplier, together with a 5-microcurie $Sr^{90}-Y^{90}$ β source. The results indicated that the intensity maximum

of the radiation is directly proportional with the atomic number of the shield material. Materials with a high atomic number may possess several maxima, one of which agrees with the calculated one; the other maxima are attributed to impurities. Small atomic number materials yield a high-intensity radiation of low-energy quanta; using heavy elements, a high-energy, low-intensity radiation is obtained. It is therefore recommended that a compound shield be used for protecting against β radiation: a low atomic number screen near the source, followed by a heavy material. The spectral distribution of the radiation from a source surrounded by such a shield indicates that the shield reduces the intensity primarily by absorbing the low-energy quanta. (TTT)

26743 APPLICATION OF THE SPHERICAL HARMONICS TECHNIQUE TO PROBLEMS IN GAMMA TRANSPORT. W. D. Lanning (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 15: 259-67(Mar. 1963).

The feasibility of applying the spherical harmonics technique to problems in gamma transport is investigated. The spherical harmonics procedure is described for one-dimensional slab geometry for plane monoenergetic sources. Energy spectra obtained by the P-3 approximation covering a wide range of source energies and materials are compared to moments results for penetrations up to fifteen mean free paths. The comparisons indicate that it is plausible to extend the method to multislab geometry for potential design applications. (auth)

Theoretical Physics

26744 A GENERALIZATION OF BORCHERS THEOREM. Huzihiro Araki (Eidgenössische Technische Hochschule, Zurich). Helv. Phys. Acta, 36: 132-9(1963). (In English)

Borchers' theorem on causal dependence of rings of operators in quantum field theory was generalized by a new method of proof, based on the uniqueness theorem for hyperbolic partial differential equations. (auth)

26745 ERGODICITY OF QUANTUM MANY-BODY SYSTEMS. Aloysio Janner (Battelle Memorial Inst., Geneva). Helv. Phys. Acta, 36: 155-63(1963). (In English)

An important hypothesis in Van Hove's proof of the ergodicity of dissipative quantum systems is the generalized microscopic reversibility condition $X_{11'}(\alpha\alpha') = X_{1'1}(\alpha'\alpha)$. It is shown how such an assumption can be avoided by deducing for a finite system a general symmetry relation which corresponds to the condition used by Stueckelberg for deriving the H-theorem. This general symmetry relation considered in the limit of an infinite system ensures the correct statistical behavior of the system for very large time. The calculation of the trace in the limiting case of an infinite system is discussed. (auth)

26746 ON THE SOLUTION OF BETHE-GOLDSTONE EQUATION FOR NON-DISAPPEARING TOTAL IMPULSE. [PART] I. Dallas T. Hayes (Universität, Göttingen, Ger.). Z. Naturforsch., 18a: 531-8(Apr. 1963). (In German)

Localized solutions of the Bethe-Goldstone equation for two nucleons in nuclear matter were examined as a function of the center-of-mass momentum (c.m.m.) of the two nucleons. The equation depends on the cmm as parameter due to the dependence upon the cmm of the projection operator appearing in the equation. An analytical solution of the equation was obtained for a non-local but separable potential, whereby a numerical solution was also obtained. An approximate solution for small cmm was calculated for a square-well potential. In the range of the approximation the two analytical solutions agree exactly. (auth)

26747 SOME PROBLEMS IN MANY BODY PROBLEM. Masanao Kitamura. Thesis, Seattle, Univ. of Washington, 1962. 153p.

Two models for systems of many interacting fermions are studied. The model for the ground state suggested by Overhauser is studied for more general spin-dependent finite short- and long-range potential. It is found that for short-range potential almost all important features of the model are given by zero-range approximation, unless the interaction is so strong that the approximation used is no longer valid. For long-range potential, it is shown that the Overhauser ground state does not exist unless there is a strong spin flip negative potential between particles. The statistical perturbation theory is extended so that it can be applied to the theory of superconductivity. In connection with this, a new simple proof of the applicability of Wick's theorem to statistical mechanics on which the statistical perturbation theory is based, is given. Application of the theory to the ground state and calculation of the effective scattering matrix (the T-matrix) are also studied. The analytic properties of the T-matrix in a complex energy plane is studied in detail in one-dimension for a simple separable potential. It is found that the T-matrix has 2 poles besides 2 cuts along the imaginary axis. The nonlinear integral equation for an energy gap is also studied. (Dissertation Abstr.)

26748 CONSTRUCTION OF POTENTIALS FROM THE MANY-CHANNEL S-MATRIX. Joseph Robert Cox. Thesis, Bloomington, Ind., Indiana Univ., 1962. 168p.

The non-relativistic s-wave scattering of a particle by a target having a finite number of discrete excited states is considered. The set of coupled radial Schrodinger equations, the S-matrix, the Green's function, and other functions to be used are introduced. A purely algebraic generalization to the many-channel case of the Bargmann potentials is given. The generalization to the many-channel case of the completeness relation for the physical wave function is included. Results were used to generalize first the Gel'fand-Levitan equations and then the Marchenko equations to the many-channel case. A proof is given of the many-channel Levinson theorem analogous to the original one-channel proof which is made possible under the general assumptions on the potential by the recent proof of Newton that f, the Fredholm determinant of the set of coupled integral equations for the many-channel scattering wave function is an analytic function regular in the upper half plane of all the channel momenta. Other more restricted results were obtained for the two-channel case when f is a meromorphic function of the energy. Two-channel S-matrices were constructed in terms of the poles and zeros of a single generating function. Two equivalent generating functions are known to exist: P, the original one, was found by Le Couteur, and f, the one with the simple analytic properties, was found by Newton. The relation between P and f was obtained A mapping is introduced which simplified the two-channel problem. It was used to reexamine the results of the preceding section and also to construct two simple two-channel S-matrices in terms of the poles and zeros of f. The solution in closed form of the coupled Fredholm integral equations of the type occurring in the Gel'fand-Levitan and Marchenko equations is

presented. Explicit solutions which are applicable to the two-channel S-matrices were obtained. Explicit two-channel potential matrices which correspond to the S-matrices constructed are included. The possibility of applications to theories of nuclear reactions and analysis of low energy scattering data, including some elementary particle reactions, is indicated. (Dissertation Abstr. 23: May 1963)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 24767, 24769, 24770, 24773, 24774, 25552, 26004, 26005, 26007, 26008, 26010, 26012, 26013, 26014, 26015, 26017, 26019, 26020, 26022, 26023, 26025, 26027, 26029, 26036, 26040, 26059, 26060, 26061, 26062, 26063, 26064, 26065, 26069, 26079, 26083, 26085, 26089, 26090, 26107, 26108, 26109, 26110, 26111, 26112, 26114, 26115, 26117, 26119, 26120, 26121, 26122, 26123, 26124, 26125, 26126, 26127, 26131, 26132, 26134, 26135, 26136, 26148, 26155, 26156, 26157, 26158, 26159, 26080, 26184, 26185, 26203, and 26238.

26749 (ANL-6701) BASIC NUCLEAR AND REACTOR INFORMATION FOR THE REACTOR OPERATOR. E. G. Greenman, ed. (Argonne National Lab., Ill.). Feb. 1963. Contract W-31-109-eng-38. 86p.

Basic nuclear and reactor information for the reactor operator is presented in order that the operator will have some knowledge of safe and efficient operation. Some principles of reactor design, construction, and operation are included. Information is given on fission processes, chain reactions, reactor structural components, auxiliary systems, reactor shielding, reactor temperature and pressure measurement, and nuclear instruments. (N.W.R.)

26750 (ANL-6717) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, APRIL 1963. (Argonne National Lab., Ill.). May 15, 1963. Contract W-31-109-eng-38. 83p.

Progress made in the reactor development program at Argonne National Laboratory is reported. Information and data are presented on Borax-V, SL-1, ZPR-III, ZPR-VI, ZPR-VII, ZPR-IX, EBR-I, EBR-II, FARET, EBWR, Treat, and liquid metal-cooled reactors. General reactor technology is presented along with nuclear safety. Reactor fuel element and material development is emphasized. (N.W.R.)

26751 (APEX-621) ANALYSIS OF THE BEM-I REACTORS: EVALUATION OF REACTOR THEORY FOR BERYLLIUM SYSTEMS. B. J. Cerimele (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Feb. 1959. Contracts AF33(600)-38062 and AT(11-1)-171. 34p.

A series of critical assemblies designated BEM-I was tested in a flexible critical experiment facility to evaluate the analytical methods available for treating beryllium systems containing lumped voids. The complexities of the (n,2n) reaction in beryllium and of the enhanced leakage due to cell voids were found to be inadequately treated by conventional methods, and, consequently, only a "best recipe" approach could be employed as an analytical tool. (auth)

26752 (CRRP-1147) THE CALCULATION OF THERMAL NEUTRON LEAKAGE IN A HEXAGONAL LATTICE. J. D. Stewart and D. C. Self (Atomic Energy of Canada Ltd., Chalk River, Ont.). Apr. 1963. 22p. (AECL-1752)

A method is presented of calculating the thermal neutron leakage perpendicular to the rods from or into a hexagonal lattice when the source q is distributed according to $\nabla^2 q + K^2 q = 0$ or $\nabla^2 q - K_i^2 q = 0$, the second equation corresponding to the spatial transient distribution in two-group theory. The method is based on the matching of fluxes and currents at cell boundaries; it is checked by making simplifying assumptions (non-absorbing moderator, line-sink rods) and then computing the neutron leakage both by this method and the microscopic-discrete method. It is found that the thermal leakage coefficient (outleakage/K^2 × absorption) decreases with K^2 and that the limiting value for $K^2 \to 0$ is less than L^2 by about the same amount as for a parallel-plate lattice. (auth)

26753 (EUR-4.e) NUCLEAR INSTALLATIONS IN THE COUNTRIES OF THE EUROPEAN ATOMIC ENERGY COMMUNITY. (European Atomic Energy Community). June 30, 1961. 39p.

The reactors in the countries of the European Atomic Energy Community are listed. The information included for each reactor is site of installation and address of managing body, characteristics, enterprises concerned, country, and status. (P.C.H.)

26754 (EUR-13.e) DETERMINATION OF FUEL PROBABILITIES BY STATISTICAL EXPERIMENTS IN A TEST REACTOR WITH REGARD TO THE UNLOADING PROCESS EMPLOYED. G. Blaesser, W. Matthes, and V. Raievski (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). June 1962. 23p.

For many types of reactors the failure of fuel elements is still the quantity limiting the maximum obtainable burnup. Since the number of failed fuel elements that are allowed to be present in the reactor and the capacity of the fuel handling machine are limited in all practical cases, the stochastic process of failure and renewal of the fuel elements were studied. Methods of statistical evaluation of experiments for the determination of the fuel failure probability are discussed. (auth)

26755 (EUR-23.e) THERMAL NEUTRON SPECTRUM IN A MEDIUM WITH TWO DIFFERENT TEMPERATURES. H. Takahashi (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). Sept. 1962. 15p.

The energy-dependent equation in the heavy gas model with the first order correction of μ is considered for the case of a non-absorbing homogeneously mixed medium, whose components have the absolute temperatures T_1 and T_2, the mass ratio μ_1, μ_2 (neutron mass to the mass of the moderator atom) and the macroscopic cross section Σ_1, Σ_2. In the heavy gas approximation, the neutron spectrum distribution is the Maxwellian distribution with the effective temperature defined by: $T_{eff} = (\mu_1\Sigma_1T_1 + \mu_2\Sigma_2T_2)/(\mu_1\Sigma_1 + \mu_2\Sigma_2)$. If the mass ratio μ approaches 1, the distribution deviates from the Maxwellian distribution. By means of the perturbation method, the simple expression for the deviated flux distribution is obtained. The more rigorous calculation is carried out by expanding the flux in terms of Laguerre polynomials of the first order of energy. The generating functions for the matrix element of scattering kernel expanded by the Laguerre polynomials, whose variable E is normalized by a temperature other than the components' temperature, are calculated for the free gas and the crystalline material. The results obtained from the above two methods show that when the moderator components have the same mass, the neutron spectra are shifted to lower energy than the Maxwellian distribution calculated by the heavy gas approximation. (auth)

26756 (EUR-24.e) FINE FLUX MEASUREMENTS ON CONCENTRIC ANNULI FUEL ELEMENTS. R. Bonalumi and G. B. Zorzoli (Centro Informazioni Studi Esperienze, Milan). 1962. 13p.

Two fine-flux measurements on concentric annuli natural uranium fuel elements, containing a hydrogenous material, are described. Two different fuel elements with different uranium content and geometry and different hydrogen content, were tested on the Aquilon II facility. Neutron detectors were metal dysprosium disks placed into the aforesaid fuel elements. The experimental results were compared with the theoretical ones, calculated by means of Amouyal and Benoist's theory; the agreement was quite satisfactory. (auth)

26757 (EUR-25.e) HEAVY WATER LATTICE BUCKLING MEASUREMENTS. R. Bonalumi and G. B. Zorzoli (Centro Informazioni Studi Esperienze, Milan). 1962. 31p.

A set of buckling measurements on Aquilon II by replacement method is described. The tested configurations were made up of concentric annuli elements fuelled by natural uranium metal and having polystyrene as simulating a hydrogenous coolant. The measured bucklings were compared with the calculated ones; the agreement was fairly good. (auth)

26758 (EUR-110.e) EURATOM'S RESEARCH ACTIVITIES. AN ILLUSTRATION: THE ORGEL PROGRAM. J. Guéron and J. C. Leny (European Atomic Energy Community). 1962. 31p.

According to the provisions of the Euratom Treaty, EURATOM aims at helping national programs and at carrying out independent actions which are not included in the national plans and which enable EURATOM to support its judgment. These actions are carried out in research centers at Ispra (Italy), Petten (The Netherlands), and Geel (Belgium). Some of these actions are managed from Brussels, which is the case for the ORGEL Program. Besides the research work performed in the research centers numerous and important research and design contracts are performed in the member countries, a large number of which is linked with the U. S.-EURATOM agreement. Further EURATOM participates also in the construction of industrial nuclear power plants, by contributing to funds, management and working teams. In the framework of the O.E.C.D., EURATOM joined the HALDEN and DRAGON projects. The objectives of the ORGEL Program are outlined in detail. A list of the various research stages is given as well as the various research facilities. In particular, the ECO critical experiment, the EXPO exponential experiment, now under construction at ISPRA, and the ESSOR reactor, now in the detailed design phase, are mentioned. (auth)

26759 (EUR-206.e) A MEASUREMENT OF THE FINE STRUCTURE OF THE THERMAL FLUX IN SIMPLE-GEOMETRY ORGEL TYPE LATTICES. A. Boeuf and S. Tassan (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 33p.

A measurement of the fine structure distribution of the thermal flux in simple-geometry natural uranium–heavy water–organic lattices was performed by activation of dysprosium detectors. Two organic compounds, i.e., monoisopropyldiphenyl (Monsanto) and diphyl (Bayer), were investigated. The results of the experiment were compared with the values calculated by the AMOUYAL-BENOIST method. (auth)

26760 (HW-SA-2915) PRODUCTION OF REACTOR FUEL OXIDES FROM MOLTEN CHLORIDE SALT SOLUTIONS. G. E. Benedict, K. M. Harmon, G. Jansen, Jr., L. K. Mudge, and F. A. Scott (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 15, 1963. Contract AT(45-1)-1350. 24p.

Laboratory and engineering scale studies on the dissolution of irradiated oxide fuels in a molten chloride salt solution, and recovery of U, Th, and Pu as their oxides by appropriate electrochemical or chemical reactions are described. Exploratory studies on the preparation of PuO_2–UO_2, PuO_2–ThO_2, and UO_2–ThO_2 solid solutions by reaction in molten chloride salt solutions are also discussed. (P.C.H.)

26761 (HW-SA-3007) SPECIAL REQUIREMENTS OF ELECTRICAL SUPPLY SYSTEMS FOR NUCLEAR REACTORS. R. E. Trumble (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 29, 1963. Contract AT(45-1)-1350. 12p.

A need for broadly accepted codes and standards specifically designed for the nuclear industry are indicated, and philosophical bases for their development are suggested. Philosophical criteria and bases found useful at Hanford are discussed. (auth)

26762 (IA-741) THE XENON EFFECT ON THE STATICS OF A THERMAL REACTOR. I. Aviram and A. Pazy (Israel. Atomic Energy Commission, Rehovoth). Mar. 1963. 36p.

The effect of xenon poisoning on the static reactivity of a thermal reactor is examined by four methods. Two of them, the exact and semi-exact solutions, consider the local effects of the xenon at every point of the reactor and in both, the global reactivity effect is obtained by performing the numerical integration of non-linear differential equations. In the other two, the perturbation method and the method of equivalent uniform poisoning, the xenon poisoning is originally regarded as an integrated effect with appropriate weighting functions while the reactivity change is obtained from correspondingly linearized diffusion equations. Both the exact solution and the method of equivalent uniform poisoning account for changes of the detailed configuration of the thermal flux within the equivalent cell while the other two do not. The values of the effective multiplication factor obtained by various methods are within a range of 100 pcm which is permissible in standard calculations of reactor statics. (auth)

26763 (NOLTR-62-155) ENERGY PARTITION OF WATER-CASED EXPLOSIONS IN AN IDEALIZED MODEL REACTOR VESSEL. James F. Proctor (Naval Ordnance Lab. Explosives Research Dept., White Oak, Md.). June 1, 1960. 141p.

Energy-partition is studied to determine model shield-plug response to excursion-type loadings simulated in idealized model reactor vessel. Energy partitions resulting from water-cased explosions surrounded by air in closed piston-fitted vessels are evaluated. Analytic equations expressing energy partition in terms of model-plug response are developed. Description of test apparatus is given, and data obtained from eleven tests are graphically and analytically treated to obtain various plug-response functions and subject energy partition. (auth)

26764 (ORNL-3382) PILOT-PLANT PREPARATION BY FLAME PROCESSES OF 1-MICRON SPHERICAL THORIA PARTICLES FOR HOMOGENEOUS REACTOR SLURRIES. C. C. Haws, Jr. and P. A. Haas (Oak Ridge National Lab., Tenn.). June 6, 1963. Contract W-7405-eng-26. 89p.

Spheroidal thoria and thoria–urania particles of about 1μ average diameter were prepared in a one-step process by flame decomposition from Th nitrate and from mixtures of Th and U nitrates. Aluminum nitrate (equivalent to 0.5 to 10 wt % alumina) was included with both systems to obtain spheroidization. A reflected oxygen–hydrocarbon flame was used and particle temperatures above 2000°C were necessary. In aqueous slurries of density 2.0, at conditions planned for nuclear reactor blankets, the particles consistently gave low values for yield stress (about 0.02 lb/ft^2), modulus of rigidity (less than 3.0 centipoise), and corrosion (type 347 stainless steel; less than 1 mil/yr in standard pump-loop test). Particle degradation in long-term pumping tests was negligible. Attempts to raise the average particle diameter to above 5μ were only partially successful. Alumina-free spheroidal thoria particles were prepared using thoria sol feeds, but the materials were not satisfactory. (P.C.H.)

26765 (ORNL-3419) MOLTEN-SALT REACTOR PROGRAM. Semiannual Progress Report for Period Ending January 31, 1963. (Oak Ridge National Lab., Tenn.). June 3, 1963. Contract W-7405-eng-26. 160p.

Progress is reported on the Molten-Salt Reactor Program. Topics covered include: reactor analysis, component development, design status, metallurgy, radiation effects, chemistry, and fuel processing. (M.C.G.)

26766 (ORNL-3421) MODELS FOR FISSION-GAS RELEASE FROM COATED FUEL PARTICLES. John W. Prados and James L. Scott (Oak Ridge National Lab., Tenn.). June 20, 1963. Contract W-7405-eng-26. 63p.

Mathematical relations are presented for estimating the release fractions of gaseous fission products from coated fuel particles and fuel elements containing them. The relations are based on simplified models of the release process, with particular emphasis on the following mechanisms: recoil, diffusion from fuel, diffusion through particle coating, and diffusion through fuel element matrix. The characteristics of fission-gas release by these mechanisms, acting singly and in combination, are considered, and the application of the theoretical relations to experiment planning and interpretation is discussed. Special attention is given to methods for analysis of data from continuous, in-pile (sweep capsule) release experiments and neutron-activation release experiments. (auth)

26767 (PAN-106/IX) CRITICAL CALCULATIONS OF THE SPECTRAL SHIFT REACTOR SYSTEMS. Krystyna Kowalska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 35p.

The concept of the spectral shift control is applied to the preliminary study of the H_2O-D_2O moderated slightly enriched reactor systems. Some problems arising in the simple calculations, using the same scheme for a wide variety of light-and-heavy-water lattices with different degrees of moderation, are pointed out. The results obtained are compared with some existing experimental measurements of the critical size. (auth)

26768 (PAN-344/IX) DYNAMIC PERFORMANCE OF THE REACTOR BEING TREATED IN SECTIONS AND BEING DISTRIBUTED PARAMETER. Wieslaw Ciechanowicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1962. 20p.

The influence of the simplifying assumptions on the accuracy of the simulation of the internal reactor loop caused by temperature reactivity coefficient is presented. The simplifying assumptions enable one to obtain ordinary differential equations from partial differential equations describing thermal processes in the reactor core. In order to show clearly these differences the temperature feedback transfer function of distributed parameter and reactor being treated in sections for some numerical examples are calculated and compared in stability considerations of internal reactor closed-loop. (auth)

26769 (PWAC-393) THE DETERMINATION OF URANIUM ISOTOPE ABUNDANCES AND REACTOR FUEL BURNUP BY MASS SPECTROMETRY. D. E. Fornwalt and M. Kahn (Pratt and Whitney Aircraft Div., United Aircraft Corporation. Connecticut Aircraft Nuclear Engine Lab., Middletown). Apr. 30, 1963. Contract AT(30-1)-2789. 30p.

The theory and use of a triple filament thermal emission source and mass spectrometer used for the measurement of isotopic abundances and reactor fuel burnup are described. It is shown that uranium isotopic abundances may be measured at the 0.03 to 95% levels with a standard deviation of 0.002 to 0.018, respectively, with an accompanying relative error of from 4.2 to 0.06%, respectively. The method used to determine reactor fuel burnup is described and is shown to have a standard deviation of 0.14 and 0.03 at 9.35% fission burnup and 1.59% capture levels, respectively. A comparison of burnup measurements made by the mass spectrometer method is shown to agree favorably with the radiochemical technique. (auth)

26770 (TID-7641) THE THIRD CONFERENCE ON NUCLEAR REACTOR CHEMISTRY [HELD IN] GATLINBURG, TENNESSEE, OCTOBER 9 THROUGH 11, 1962. (Oak Ridge National Lab., Tenn.). 390p.

Twenty-five papers and 10 abstracts of papers presented at the 1962 Conference on Nuclear Reactor Chemistry are given. Separate abstracts were prepared for 23 papers. Two papers were previously abstracted for NSA. (M.C.G.)

26771 (TID-7641(p.1-14)) TRANSPORT OF PARTICLES ACROSS BOUNDARY LAYERS. A. C. Chamberlain (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). (AERE-M-1122)

The transport of particles to smooth or slightly rough walls with turbulent boundary layer is considered. Theory is discussed. Results of experimental studies with radioactive particles are discussed. Information on the dry deposition of small particles to grass is summarized. (M.C.G.)

26772 (TID-7641(p.15-42)) PARAMETRIC STUDIES OF FISSION-PRODUCT RELEASE FROM UO_2 FUELS. G. W. Parker, G. E. Creek, R. A. Lorenz, and W. J. Martin (Oak Ridge National Lab., Tenn.).

An analysis of potential fission-product release from UO_2 lead to the conclusion that no simple set of conditions can adequately describe more than one single reactor accident. The following parametric studies are in progress: effect of release mechanism, effect of atmosphere on release, effect of fuel burnup, effect of quantity of fuel, effect of center melting as compared to external melting, and effect of environment. Some comparisons were made of the release of fission products from UO_2 by diffusion, oxidation, and melting at various burnup levels. Release of certain fission products by diffusion and oxidation processes was found to increase with increasing burnup by a factor of 5, while little effect of burnup in releases resulting from melting was noted. Atmosphere had little effect except that related to chemical reaction. The size of particles produced on cooling gas containing UO_2 vaporized from molten

UO_2 was found to be only slightly affected by atmosphere. Increasing the amount of UO_2 melted was found to result in lower vaporization rates. Based on scattered data, the rate appeared to be proportional to the solid angle subtended by the exposed UO_2. A factor of 15 was observed between amounts of UO_2 vaporized utilizing two methods of melting with widely different quantities of UO_2. Center melting of small UO_2 pins indicated probable reduction in release due to maintenance of integrity of the UO_2 surface. Metal claddings of zirconium and stainless steel resulted in different types of UO_2 melts because zirconium formed a solid solution with the UO_2 while stainless steel segregates completely. (auth)

26773 (TID-7641(p.43-52)) RELEASE OF FISSION PRODUCTS BY THE IN-PILE DESTRUCTION OF FUEL. B. F. Roberts, C. E. Miller, Jr., R. P. Shields, and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.).

A series of in-pile experiments is being conducted to study the fission product release during a simulated reactor accident in which the fuel elements are destroyed by melting or vaporization as a result of uncontrolled heat generation or loss of reactor coolant. In a typical in-pile meltdown experiment, a miniature UO_2 fuel element clad in stainless steel is placed in a helium-filled container of stainless steel which is lined with ceramic thermal insulation. This assembly is moved to a position close to the top of the lattice of the ORR to build up traces of fission products in the UO_2 specimen. At the end of the irradiation period the assembly is lowered to a position where fission and gamma heat cause the specimen to melt. Helium gas sweeping over the specimen carries gas-borne fission products to suitable filters and traps where they are separated and collected. After the specimen is withdrawn from the flux, the furnace, filters, traps, and associated tubing are removed from the reactor. These parts are then cut up in a hot cell, examined, and finally analyzed for fission products. Eight experiments were performed and their radiochemical analyses completed. Satisfactory material balances were obtained for individual fission products and for uranium. The percentages of various fission products which were released from the UO_2 in the puddle on the floor of the fission-heated furnace were determined. Essentially quantitative release of rare gases was indicated by the amounts of krypton and xenon found in the liquid-nitrogen-cooled trap. Data from one experiment showed that iodine was also released quantitatively. More than half of each of the other fission products was released. From one third to one half of the UO_2 was transferred from the puddle to other regions of the furnace. Fission product release was generally greater in the experiment in which the UO_2 was held molten longer than in the other experiments and which was irradiated at 1200°C for 24 hr after the cladding was inadvertently melted. This experiment produced crystalline deposits of uranium oxide not found in the other experiments. The release of Sr, Ba, and Ce was substantially greater than had been observed in out-of-pile experiments conducted by Parker, Creek, and Martin. This difference in behavior may have resulted from the longer melting time of the in-pile experiment or the higher melting temperature. Beryllium oxide used as a sample holder in out-of-pile experiments lowered the melting point of the UO_2. Although most of the fission products were released from the UO_2 puddle, they were almost entirely retained inside the high-temperature zone of the furnace with the exception of iodine and the noble gases. (auth)

26774 (TID-7641(p.53-60)) SOME PROBLEMS AND OBJECTIVES IN REACTOR GAS DISCHARGE FILTRATION RESEARCH. J. R. Beattie (United Kingdom Atomic Energy Authority. Health and Safety Branch, Risley, Lancs, England).

A program of research and development on methods of removal of fission products from reactor gas or steam discharges is described. First attention was given to the filtration problems of metal-fueled gas-cooled reactors because of the importance of the "magnox" reactor in the United Kingdom program. Attention is now being given to filtration problems appropriate to accident conditions in water reactors, the oxide-fueled advanced gas-cooled reactor, the high-temperature gas-cooled reactor, and to the sodium-cooled fast reactor. Special problems peculiar to each system are discussed, in turn, with reference to current and future research work. Difficulties of the removal of volatile iodine and cesium now appear well advanced toward solution by the use of materials such as silver or charcoal, and absolute filters seem capable of removing the other isotopes as particulates with some reservations as to the size of the finest particles. Work was carried out on problems peculiar to the use of charcoal filters in reactor gas discharge streams. One such problem is heating of the charcoal and migration of iodine through the bed at elevated temperatures. Other problems arise with absolute filters, for example, blockage if large quantities of fine particulates penetrate the pre-filters. Since the program was broadened to include a study of water reactor systems, the filtration problems peculiar to these were considered. From the theoretical and practical viewpoint there appears to be some case for a revival of interest in aqueous scrubber removal systems, and some aspects of this are discussed. It was concluded that the prospects are good that filtration systems, which will ensure the effective containment of fission products which might be released from a major reactor accident, can be designed, built, and operated. (auth)

26775 (TID-7641(p.61-74)) STUDIES OF FISSION GAS RELEASE FROM IN-PILE TESTS. II. CORROSION INDUCED LOSS FROM BeO CERAMIC FUEL ELEMENTS. P. K. Conn, E. A. Aitken, C. C. Browne, and R. E. Fryxell (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati).

Fission product release data for I^{131} and short-lived rare gases were obtained from dynamic in-pile tests on BeO fuel elements operated in wet and dry air with the dew point ranging from 4 to −45°C. The fuel element used consisted of chemically stabilized UO_2 dispersed in a BeO matrix and was fabricated in a tubular configuration to greater than 98% theoretical density. The fuel elements were either uncoated or coated on the bore. The tubes were tested under self-heat generating conditions in test assemblies which confined almost all the air flow to the bores of the tubes. The fission product release was measured by sampling 0.001 to 1% (depending on the test facility) of the total air flow with carbon traps and analyzing the traps for the adsorbed fission products. When possible, the trap data were corrected for deposition in the off-gas ducting between the test specimens and the traps, thus permitting a calculation of the fractional release from some tests. The rate controlling step of the corrosion of BeO by water vapor under turbulent flow conditions was assumed to be the diffusion of the hydrolysis product, $Be(OH)_2$, g, across the gaseous quiescent boundary layer adjacent to the tube surface. If it is assumed that corrosion proceeds at a constant rate, two modes of fission product release are

possible, each leading to a slightly different time-dependence. The corrosion of the surfaces of the fuel elements will release fission products that have accumulated in the BeO matrix and increase the recoil loss because of the exposure of a greater volume of dispersed fuel particles. The release from the matrix yields a time-dependency related to the fission product concentration buildup in the matrix while the increased recoil release yields a linear time-dependence. The fission product release data obtained from the reactor tests in wet air could be interpreted by use of the two corrosion-induced release modes. Experimental data from uncoated fuel elements were in agreement with a calculated release based on the loss of accumulated fission products. The I^{131} fractional release was observed to increase during the experiments and the shorter-lived fission gases increased only slightly. Experimental data obtained from tubes coated on the bore indicated that corrosion was prevented; however, in some tests a corrosion-induced release was observed which was caused by corrosion on the uncoated outside surfaces of the fuel elements. This corrosion was due to wet-air leakage around the tubes and was dependent on air-flow rates and test-assembly design. During backside corrosion, both I^{131} and the shorter-lived rare gases increased by about the same factor, which indicated that a greater volume of fuel particles was being exposed. The experiments lasted 100 to 165 hr at temperatures of 1375 and 1425°C and the observed increase in the I^{131} fractional release was a factor of 8 to 10. Under the same test conditions in dry air (−40°C dew point) and for the same materials, no increase in fission product release was observed. Also, when the air was changed from wet to dry during the same test, the fractional release due to corrosion stopped. Additional evidence of corrosion was obtained during disassembly and postirradiation examination of the tests. Beryllium oxide was observed to be transported from the hottest regions to cooler regions within the test assemblies. (auth)

26776 (TID-7641(p.75-93)) THE TRANSPORT AND DISPERSION OF IODINE-131 FROM THE SL-1 ACCIDENT. Norman F. Islitzer (Weather Bureau, Idaho Falls, Idaho).

The nuclear accident at the Stationary Low Power Reactor No. 1 (SL-1) on January 3, 1961, at the National Reactor Testing Station in southeast Idaho occurred under meteorological conditions which favored maximum transport of any airborne radioactive effluent with the least possible dilution. Although the reactor core was severely damaged, the building itself was not penetrated by any projectiles and provided a high degree of containment. Extensive ground and aerial monitoring, including vegetation samples, disclosed that there was no large release of fission products during the actual explosion. It was determined, however, that there was a slow but steady release of effluent, which consisted primarily of I^{131}, for several weeks after the accident. An inventory of the daily release was obtained, which was estimated to be 10 curies of I^{131} in the first 24-hr period after the accident and a total of 80 curies by the end of January. Thereafter, the release rate was down to near 0.2 curies per day for the next two to three weeks after which it was undetectable. A deposition velocity for I^{131} of 0.2 cm/sec was computed from samples collected on the vegetation. This computation required a knowledge of the density of the desert-type vegetation, which was found to be approximately 50 gm/m. Some samples of I^{131} were also collected on the patchy areas of snow that existed after the accident and in the soil. These revealed deposition velocities about $\frac{1}{4}$ that over the vegetation. There was nearly an even separation between particulate and gaseous I^{131} as indicated by the even division of radioactivity between the pre-filter and the charcoal trap behind the filter used in the air samplers. The manner in which I^{131} was released from the SL-1 and the type of carrier, if any, to which it was attached, are unknown. I^{131} was eventually detected throughout the entire environmental monitoring network extending 100 miles down the Snake River Plain. The results of the air sampling showed a mean air concentration of I^{131} of about 10^{-12} μc/cc in the first six weeks after the accident in the populated areas to the east of the NRTS, some 50 miles away. This average air concentration increased to about 10^{-10} μc/cc within a mile of the SL-1. Comparisons of predicted and measured average air concentrations for this period were in disagreement by a factor of more than 10 at distances beyond 15 miles, with predicted air concentrations showing the unusual result of being too low. It is believed that the confining effects of the mountains forming the walls of the Upper Snake River Plain and the diurnal variation of winds normally experienced in this region prevented the proper use of diffusion equations for this purpose. A simple volumetric-type calculation gave fairly good agreement between predicted and measured air concentrations. (auth)

26777 (TID-7641(p.112-29)) INTERACTIONS BETWEEN RADIONUCLIDES AND AEROSOLS IN THE RESPIRABLE SIZE RANGE. D. K. Craig (Rochester, N. Y. Univ.).

Investigations were initiated to characterize the adsorption of radioactive fission products onto suspended particulate material in the respirable size range as a function of some important physical parameters. Ideally the experiment requires a series of monodisperse aerosols, with particle sizes adequately covering the range of interest (0.01 to 10 μ diam for unit density spheres), of uniform and adjustable concentrations, introduced into a large test chamber under dynamic conditions. Both the temperature and the relative humidity of the atmosphere in the test chamber should be subject to accurate control at a range of values. It is also required that known and variable concentrations of several radionuclides with different physical and chemical properties be introduced into the test chamber. Finally, sampling equipment is required that will enable the accurate evaluation of aerosol particle size, concentration, and adsorbed activity. Monodisperse aerosols covering the required range of particle sizes are difficult to generate, and can only be obtained for a limited number of materials. If a polydisperse aerosol must be used, then techniques are required to separate the aerosol into an adequate number of aerodynamic size ranges in sampling in order that the above analysis can be carried out. The experimental techniques that were adopted (or that are planned) in an attempt to carry out these investigations are described. Various aerosol generation techniques are described, as well as the methods used to characterize them. Preliminary experimental results are also presented. (auth)

26778 (TID-7641(p.130-47)) CHARACTERIZATION OF MILLIMICRON RADIOACTIVE AEROSOLS AND THEIR REMOVAL FROM GASES. W. E. Browning, Jr. and R. D. Ackley (Oak Ridge National Lab., Tenn.).

Radioactive materials may appear in gases in the form of true gases or vapors, particles of various diameters, or vapors absorbed on particles. Measurements which discriminate between the various forms of radioactive materials help to elucidate their behavior. A method was developed for characterizing radioactive materials in

gases in terms of their diffusion coefficients. These diffusion coefficients are determined by measuring the distribution of radioactive material on the inside wall of a channel which is carrying the gas stream under laminar flow conditions. The method is capable of discriminating between various sizes of particulate material over the range of 0.004 to 0.3 μ and radioactive vapors. This method was applied in an investigation of the efficiencies of various gas cleaning materials for removing radioactive iodine from air. In these tests, aluminum oxide particles 0.004 μ in diam were introduced into the gas stream to simulate condensation nuclei which may be present in reactor gas streams. The physical properties of these particles are similar to those which appeared spontaneously in earlier radioiodine experiments. An activated charcoal adsorber bed $^3/_4$ in. thick and $^5/_{16}$ mesh through which the contaminated gas was passed at a velocity of 5 linear ft/min removed at least 99.9% of that part of the iodine which was actually in the form of a vapor. However, that part of the iodine which was associated with the Al_2O_3 particles was removed with an efficiency of only 75 to 90%. Similar tests were conducted on a high efficiency particulate filter medium which has a rated efficiency of 99.97% for 0.3 μ particles. This material reduced the concentration of iodine in the form of vapor only negligibly and exhibited an efficiency of ~50% for iodine associated with 0.004 μ Al_2O_3 particles. It can be concluded that radioactive materials which are associated with particles approximately 0.004 μ in diam are capable of penetrating both filters and adsorbers. Similar tests are being conducted with other gas cleaning systems. The method was applied to the determination of particle sizes of radioactive aerosols produced in the in-pile melting of UO_2 fuel. By analyzing the distribution of various nuclides along the wall of a cylindrical tube carrying the helium gas stream from the in-pile melting chamber, it was possible to determine the amounts of the various fission products which are associated with very fine particulate material of the type investigated in the radioiodine studies as well as with other physical forms. (auth)

26779 (TID-7641(p.148-54)) BeO CERAMIC FUEL MELTDOWN EXPERIMENTS USING A PLASMA JET. P. K. Conn, R. L. Stuart, J. Y. Gerhardt, and P. H. Wilks (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati).

Experiments were performed to determine the feasibility of using a plasma jet heat source for melting BeO ceramic fuel elements and to obtain fission product release data from these melts. The fuel element used was chemically stabilized UO_2 dispersed in a BeO matrix; the matrix was over 90 wt % of the fuel element. The assembly in which the melts were performed consisted of a plasma jet heat source sealed in a water-jacketed stainless steel chamber; the melts were accomplished by playing the plasma jet flame onto the specimen, which sat in a beryllia specimen holder. The course of the melt and the approximate temperature of the sample were both followed through viewing ports attached to the tank. The argon from the plasma jet was used to carry the fission products from the tank through a manifold to carbon traps. A vacuum pump was used on the back side of the traps to maintain the system at a slightly negative pressure as a precautionary measure. Melting of this ceramic fuel element was accomplished within the test assembly, but it was not easy to control the amount of sample melted within a prescribed melt time, nor could the sample be held in a molten puddle. Some uncontrollable ablation of the molten portion of the sample occurred, caused by the high-velocity plasma flame. These factors along with heavy deposition in the tank made it impossible to get rate data. The amount of sample melted in these experiments varied from 50 to 100%; the I^{131} release varied from 49 to 90%, the Ba^{140} release varied from 3 to 9%, and the Sr^{89} release varied from 1 to 2%. In the process of doing a materials balance on each melt, other analytical results were obtained which were significant. In the sample which was only 50% melted, the unmelted portion was found to contain 49% of the total I^{131} sample inventory, and 61% each of the total Ba^{140} and Sr^{89} sample inventory. Also, it was possible to recover most of the ablated material from one sample as gross particulate; this material contained 80% of the total Sr^{89} release, 13% of the total Ba^{140} release but only 0.16% of the total I^{131} release. These data indicated that the amount of I^{131} release was related to the amount of sample made molten. Further, a molten state was necessary for copious iodine release and once the molten state was achieved the iodine was released very rapidly (in less than 3 sec). Because the barium and strontium release was strongly influenced by the ablation of the molten portion of the samples, it is believed that a more representative value for the release from these fuel elements because of meltdown is that which carried to the carbon traps, 0.1 to 1% for Ba^{140} and 0.01 to 0.04% for Sr^{89}. (auth)

26780 (TID-7641(p.169-84)) FOAM AND DIFFUSION BOARD APPROACHES TO CONTAINMENT OF REACTOR RELEASES. Leslie Silverman (Harvard Univ., Boston. School of Public Health).

The experimental studies described were intended to provide economic safety devices for reducing the consequences of radioactive releases. In the event of a serious fission product release in a reactor accident or in a chemical plant, it would be desirable to have some cleanup mechanism for minimizing or containing the release. Two procedures now applied in reactor safeguarding for environmental control are identified as containment or confinement techniques. In containment, design criteria require that all pressure releases, such as from stored energy, metal-water, or chemical reactions, be contained within an unfired pressure vessel. In confinement, a continuous flow of air passes through the reactor building creating a negative pressure. It then flows through an air cleaning system composed of a scrubber or adsorber and a high efficiency filter. The building is not a containment structure since it cannot resist a pressure change of more than a few inches of water. Even though a containment vessel is an unfired pressure chamber, its leak rate may be as much as 5% of the vessel volume per day. It may also rupture if design conditions are exceeded or internal missiles develop from ruptures, etc. The foam approach is intended to encapsulate released contaminants by means of high-expansion foam. The foam used was a high-expansion (1000 to 1) lauryl sulfate solution to which various iodine reactants were added. The results obtained with iodine concentrations released inside a 1200 ft^3 chamber are shown in tabular form. These data indicate a marked reduction in iodine concentration; as much as 90 to 95% of the iodine was removed within 10 min. Particulate removal of both 0.2 and 0.074 μ uranine aerosols appeared equally effective. A dynamic system in which continuously generated high-expansion foam is mixed with the aerosol in a duct was evaluated. At a flow rate of approximately 40 fpm, an average of 82% removal was measured within 5 to 10 diam of duct length. The foam provides a stable extended surface which appears to

resist high radiation levels. Only alpha activity is believed to cause foam destruction, and continuous generation should control this factor. One other environment of interest is steam which is expected to be released in a water-cooled-reactor accident. Studies indicated that foam, if it is generated continuously, will condense steam. In the diffusion board containment concept the ideal diffusion board is a cell-like structure which has the capability of resisting pressures encountered in postulated reactor accidents or releases. The accident often postulated for a water-cooled reactor and some gas-cooled reactors involves a serious or total loss of coolant. The structure must resist the inherent steam pressure developed by its sudden release from a severed coolant line and any shock wave that might be created. It is believed that a diffusion structure could be made strong enough to resist both forces. It could also act as an air cleaner and would replace the present unfired pressure vessels made of steel plate. Such a structure would be able to function for both water- and gas-cooled reactors, and could handle many types of releases. A honeycomb structure with two filter layers and a contained adsorbent with a strong structure was developed. It is now undergoing evaluations. Its performance in removing submicron particulates and halogens from gas streams is expected to exceed criteria. Other porous media were studied such as porous carbon and impregnated refractory fiber adsorbent combinations. Descriptions of these media and their performance are presented. (auth)

26781 (TID-7641(p.189-99)) STUDIES ON PYROLYSIS PRODUCTS OF PURE BIPHENYL. W. T. Rainey, Jr. and L. B. Yeatts, Jr. (Oak Ridge National Lab., Tenn.).

A study was made of the thermal decomposition of biphenyl. Pure biphenyl was pyrolyzed to about 1% decomposition in evacuated glass ampoules under carefully controlled conditions. The products were separated on a vacuum line into three fractions: permanent gases and low boiling hydrocarbons, compounds boiling at temperatures between room temperature and the biphenyl boiling point, and the higher boiling polymeric materials. These fractions were analyzed by gas chromatography. The gaseous fraction was resolved on a dual column unit of silica gel and Molecular Sieve 5A operated at room temperature. The intermediate and high boiling materials were determined by the use of the temperature-programmed Apiezon L-Carbowax 20M and lithium chloride columns, respectively. The use of these columns in quantitative analyses are discussed. Determination of reaction product compositions and rates of formation in the temperature range of 350 to 500°C is in progress. Results of pyrolysis at 425°C for 16 hr gave a gaseous product consisting essentially of hydrogen and methane. Ethane, acetylene, ethylene, and three unidentified gases were present in small quantities. Benzene was the sole component in the intermediate boiling range. The high boiling fraction consisted of ortho-, meta-, and para-terphenyls, and meta- and meta, para-quaterphenyls with a small amount of higher boiling material. These products were obtained in a run giving about 0.5% decomposition. (auth)

26782 (TID-7641(p.202-20)) THE ELECTRON IRRADIATION OF THE POTENTIAL ORGANIC COOLANT FOR POWER REACTORS, SANTOWAX O-M. W. D. Mackintosh (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Mixtures of terphenyls were previously shown to be suitable coolants and/or moderators for nuclear reactors intended for power production. A mixture containing 2% para and a 2:1 ratio of ortho to meta terphenyl was investigated as a potential coolant. This mixture has a low melting point and hence does not require trace heating of the reactor cooling system. Part of the investigation consisted of irradiating the coolant, designated Santowax O-M, with 1-Mev electrons using a Van de Graaff accelerator. Thoroughly degassed samples were irradiated in a stainless steel cell fitted with a 0.002 in. Inconel window. The dose was determined by recording the accumulated charge input with a current integrator. A beam current of 50 μa was used and the dose rate was approximately 73 w/g. Various temperatures were obtained by placing the cell inside a controlled furnace during irradiation. A calibrated thermocouple was immersed in the sample out of the line of the electron beam to determine the temperature. A precision of ±5°C was normally obtained. The gaseous decomposition products were withdrawn from the cell into a conventional gas line for fractionation into two parts, one volatile in liquid N_2 temperatures and one condensable at liquid N_2 temperatures but volatile at the temperature of a mixture of dry ice and acetone. The volume of each fraction was measured. The first fraction was then analyzed for H_2 and CH_4 by use of a mass spectrometer. The products of radiolysis which boil at a higher temperature than para-terphenyl (HB fraction) were determined collectively by microsublimation. The fraction of the original components remaining in the irradiated sample was determined by gas chromatography. The viscosity and density of the irradiated sample were measured. Three series of irradiations were carried out. Series (a) consisted of irradiations at a temperature of 375°C with total doses varied from 4.4 to 105 whr/g. In series (b) the temperature was maintained at 450°C and the dose varied from 4.4 to 26.4 whr/g. In series (c) the doses were all 8.8 whr/g but the temperature was varied from 350 to 450°C. In series (a) and (b) the stability of Santowax O-M to electron irradiation at two temperatures was determined by calculation of the G values for the formation of high boilers, total gas, hydrogen and methane, and for the disappearance of the components both as a group and individually for ortho- and meta-terphenyl. These results were compared with those obtained for other terphenyl mixtures. At 450°C the curve of percent decomposition products/dose plot was considerably steeper than the curve for irradiation at 375°. The rate of decomposition at a dose of 8.8 whr/g at temperatures from 350 to 405°C increased slightly with increasing temperature, an effect also found by previous workers. However, previously published results did not include the ranges 405 to 450°C. In this range a very marked increase in the rate of decomposition with temperature was found. The amount of decomposition product formed by pyrolysis alone at these temperatures in the time required for the irradiation was shown to be insignificant. (auth)

26783 (TID-7641(p.223-33)) RADIOLYSIS OF BENZENE–POLYPHENYL MIXTURES. A. J. Moffat (Phillips Petroleum Co., Bartlesville, Okla.).

At present, a mixture of the three isomeric terphenyls is the material of choice as a coolant-moderator in organic reactors. Radiolytic damage produces a wide variety of "high boiler" products from the terphenyls. Separation and identification of all the numerous polyphenyl products would be difficult or perhaps impossible. To circumvent this analytical problem, simple mixtures of benzene and individual polyphenyl isomers were irradiated and the products analyzed. The individual polyphenyl reactivities

were compared to benzene and hence to each other. The following mixtures were irradiated with 6-Mev electrons (average) from a linear accelerator: benzene-biphenyl, benzene-perdeuterobenzene, benzene-*m*-terphenyl, benzene-o-terphenyl, and perdeuterobenzene-biphenyl. The major polyphenyl products were identified and the amount of each determined by gas-solid chromatography (lithium chloride on firebrick). The reactivities of the individual polyphenyls were calculated with respect to benzene. The calculations were based only on polyphenyls (main product) in the high boiler. The probability for the generation of reactive species was calculated. In addition, it was possible to calculate the relative reactivities of the parent molecules to attack by the reactive species. The relative scavenging power of the individual polyphenyls was determined. This treatment of simple systems leads to a practical treatment of complex polyphenyl mixtures. (auth)

26784 (TID-7641(p.236-47)) RARE EARTH DECONTAMINATION OF URANIUM BY PRECIPITATION OF AMMONIUM DIURANATE. Fausto W. Lima and Ursula E. Pfeiffer (Brazil. Instituto de Energia Atômica, São Paulo).

Precipitation of uranium with ammonia as ammonium diuranate (ADU) is a common procedure as a final step of the purification of that element for nuclear purposes. However, this precipitation is not specific for uranium and other elements, such as rare earths, that might be present which would be entrained by the ADU precipitate. One way to avoid this entrainment is to complex the rare earths with a chelate compound such as ethylenediaminetetraacetic acid (EDTA). Even so, a certain amount of the rare earths will still coprecipitate. It is shown that decontamination factors for the complexed rare earths is a function of the proportion of rare earths, being higher for large amounts of rare earths present in the uranium, such as 100 ppm, than for small amounts, such as 2 ppm. Values for decontamination factors for uranyl nitrate solutions with 100 ppm of total rare earths are about 60, and about 1.0 or 1.5 for 2 ppm. Solvent extraction methods for purification of uranium may give a decontamination factor from 10^3 to 10^4 for rare earths. These values for decontamination factors may give uranyl nitrate solutions, before precipitation of ADU with ammonia, containing as much as 0.2 to 2 ppm of total rare earths, especially for uranium obtained as a by-product from treatment of monazite sands for thorium production. A concentration of 2 ppm of total rare earths would give about 0.2 ppm of the rare-earth elements of high-neutron-absorption cross section, including gadolinium, samarium, europium, and dysprosium. In order for natural uranium to be used as nuclear fuel, it must contain less than 0.2 ppm of these rare earths. Decontamination factors of about 1.0 or 1.5 for these low concentrations of rare earths would thus not give the required purification by precipitation of ADU in the presence of EDTA. However, adding about 98 ppm of a rare earth of low-neutron cross section, such as yttrium, to a uranium sample containing 2 ppm of total rare earths, would raise the decontamination factor from 1.5 to about 60 for total rare earths. This would reduce the concentration of the dangerous rare earths from 0.2 to about 0.003 ppm and, for the added yttrium, from 98 to about 2 ppm. Data obtained for decontamination factors and percentage of coprecipitation for rare earths by precipitating uranium with ammonia, as ADU, in the presence of EDTA and of various amounts of yttrium as the carrier ion are presented. The influence of concentration of EDTA is reported. Another element of behavior similar to the rare earths, such as thorium, was tried as the carrier ion in place of yttrium. The effect of aging of the ADU precipitate was examined as well as the effect of concentration of uranyl nitrate solutions on the percentage of coprecipitation and on the decontamination factors. Europium-152-154 was used as the labeling isotope in all experiments. Calculations were performed by measuring the area at the photopeak of 0.34 Mev in a one-channel gamma spectrometer. (auth)

26785 (TID-7641(p.248-62)) PRECIPITATION OF BERYLLIUM HYDROXIDE WITH INERT GAS–AMMONIA MIXTURES. A. Sūner, C. Bamberger, and F. Laguna (Argentina. Comision Nacional de Energia Atomica, Buenos Aires).

The precipitation of beryllium as hydroxide is almost a necessity during a processing of materials containing this element. From the point of view of filtration properties, beryllium hydroxide precipitates can be classified into two main groups; dense, granular precipitates with high filterability and gels that are difficult to filter. Dense granular precipitates are usually obtained by hydrolysis of alkaline beryllates or by Pechiney's method in which alkali solution is continuously mixed with beryllium solution keeping a constant pH at 98 to 100°C. When the processed beryllium is to be used in nuclear applications, it is not very convenient to obtain the hydroxide by hydrolysis of beryllates due to the high cross section of sodium and potassium which may be adsorbed on the precipitate; Pechiney's method is rather slow and also requires careful control when 100-g quantities or less are processed. Work was performed in order to find conditions under which easily filterable beryllium hydroxide having a minimum of adsorbed metal ions could be obtained by use of inert gas-ammonia mixtures, as described in previous publications. Carman's filtration theory was employed for the evaluation of the filtering properties of the hydroxide precipitates obtained in this investigation. Only the decrease in mother liquor concentration with increasing washing solution volume was considered in precipitate washing studies. Two kinds of work were performed: precipitation under different conditions, and precipitate filtration and washing at constant pressure. The pH of the solutions was adjusted to 5.1 ± 0.2 with ammonium hydroxide prior to precipitation, in order to minimize the operation time. The pH at which precipitation was complete could be detected fairly well by use of the bromothymol blue-color change. The following precipitation conditions were studied: temperature, 60 to 95°C; beryllium concentration, 0.07 to 12.5 g/l; ammonia concentration in the gaseous mixture, 4 to 100%; precipitation time, 15 min to 2 hr; and effect of small quantities of cationic impurities. Phenol red was used as a tracer of mother liquor in the washing studies and the efficiency of different solutions in decreasing phenol-red concentration was measured by means of a spectrophotometer. Precipitation time was the variable that had the greatest effect on the process. It was not possible to obtain an easily filterable precipitate in less than 20 min. The minimum time required for the precipitation depended on the value of other variables. Minimum beryllium concentration with which a good precipitate was obtained was 1 to 1.5 g/l. Specific filterability values varied linearly with ammonia concentration and the proportionality constant was a primary function of the precipitation time and, to a lesser extent, of the beryllium concentration. The optimum precipitation temperature was chosen as 75°C because ammonia losses were acceptable and the precipitate did not stick to the reaction vessel too much.

Small quantities of cationic impurities (total amount 1% referred to BeO) showed no effect on the filterability of the precipitates. (auth)

26786 (TID-7641(p.266-82)) A HIGH TEMPERATURE CALORIMETER FOR THERMAL PROPERTY MEASUREMENTS OF PLUTONIUM METAL. T. K. Engel, K. C. Jordan, D. M. Scott, and G. W. Otto (Mound Lab., Miamisburg, Ohio).

A twin-bridge calorimeter constructed for measurements of the thermal capacities and the latent heats of phase transformations in metal systems was put into operation. With suitable adaptations thermal conductivity of metal systems can also be determined. The calorimeter consists of a sample and dummy (reference) chamber, located in the isothermal region of a cylindrical nickel block. The chambers are connected electrically by means of a differential platinum, resistance-bridge network. As the block undergoes a thermal transient, the differential unbalance of the bridge is recorded. The total time integral of the transient (area under the differential curve) is proportional to the mass, thermal capacity of the sample, and the temperature interval. The area under the curve is calibrated when a measured amount of electric current is passed through resistance windings inside of the sample chamber, and the resulting unbalance of the bridge is recorded and integrated. Since a temperature differential of only ± 0.4°C between the calorimeter chambers results in full-scale deflection of the recorder, precise temperature control of the block is imperative. This is achieved with a servo-type system in which the unbalance from a second differential-resistance bridge causes heat to be supplied to the block. This method of temperature control results in chamber differentials of only ± 0.001°C at room temperature and ± 0.01°C at 650°C under steady-state conditions. The temperature measuring elements (the platinum bridges) are calibrated directly against a standard Pt vs Pt–10% Rh thermocouple. The absolute sample temperature can then be determined to within ±0.1°C and relatively to ± 0.005°C when the calorimeter is at equilibrium. The specific heat of "A" nickel (99.4% nickel + cobalt) was determined from room temperature to 600°C. The average deviation from two literature values was 0.55% which is within the experimental error of the calorimeter. The precision of the calorimeter was also calculated and found to be ± 0.5% at 600°C. Heat measurements were extended to a study of the alpha-to-beta-to-gamma transformations of plutonium metal. For very low heating rates, the observed alpha-to-beta transformation temperature displayed a strictly linear relationship to the heating rate. The relationship between the heating rate, the observed transformation temperature, the thermal diffusivity, and the radius of a cylindrical specimen is being investigated. The latent heats of the alpha-to-beta and the beta-to-gamma transformations were measured and agreed closely with recently published values. Thermal properties measurements of the higher temperature transformations in plutonium, including the heat of fusion, are in progress. (auth)

26787 (TID-7641(p.283-9)) A COMPARISON OF IRON AND NICKEL AS FAST NEUTRON DOSIMETERS. C. D. Bingham (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Several dummy fuel elements containing various structural materials were irradiated in the Organic Moderated Reactor Experiment (OMRE). Corrosion effects in the organic medium as well as changes in mechanical properties were investigated as functions of neutron exposure. Nickel and cobalt-aluminum wires were strung along the center rod of the specimen holder to serve, respectively, as fast and thermal flux monitors. Fast flux dosimetry for Dummy Element I (DE-1) was accomplished by means of the $Ni^{58}(n,p)Co^{58}$ reaction. The nickel wires for DE-2 were lost; thus alternate means were sought for determining the fast neutron dose ex post facto. The reaction $Fe^{54}(n,p)Mn^{54}$ was chosen since investigations of this reaction showed its applicability to fast neutron dosimetry and among the test specimens there was material of known iron composition (type 4130 alloy steel). Fluxes for DE-1 determined from $Ni^{58}(n,p)Co^{58}$ (91-mb cross section averaged over a Watt spectrum) were corrected for in-pile transmutation of Co^{58} whose high thermal capture cross section and resonance integral were recently reported. Mn^{54} was determined by gamma spectrometry and the fast flux calculated using a 47-mb cross section averaged over a Watt spectrum. The contribution of $Mn^{55}(n,2n)Mn^{54}$ was shown to be negligible. Since DE-1 and DE-2 were in adjacent or mirror-image positions in the OMRE, a simplifying assumption was made that the elements saw the same fluxes (averaged over power variations). A comparison of the fluxes calculated from iron and nickel data showed agreement within ± 4%. (auth)

26788 (TID-7641(p.290-9)) PHASE STUDIES OF THE MSRE FUEL SYSTEM. R. E. Thoma, C. F. Weaver, H. Insley, and G. M. Herbert (Oak Ridge National Lab., Tenn.).

Low melting solvents for fissionable and fertile materials are available in the Li^7F-BeF_2 system. Molten-fluoride fuel mixtures containing tetravalent uranium can be protected from inadvertent precipitation of UO_2 by hydrolysis through incorporating zirconium in the fuel mixture in approximately a 4-Zr to 1-U atomic ratio. Such fuel mixtures can be altered to become fuels for single-region converter or breeder reactors by further incorporating requisite concentrations of thorium fluoride into the molten mixture. A complete description of phase behavior of the five-component system, $LiF-BeF_2-ZrF_4-ThF_4-UF_4$, is impractical. However, isomorphism of the tetrafluorides results in the occurrence of similar phase behavior in the three $LiF-BeF_2-MF_4$ ternary systems. The ternary system $LiF-BeF_2-ZrF_4$ is important in these studies, since ZrF_4 is the major MF_4 constituent of the fuel. Emphasis in MSRE phase studies was therefore directed to $LiF-BeF_2-ZrF_4$ mixtures containing >50 mole % LiF, where crystallization typical of the initial freezing behavior of the MSRE fuel occurs. The ternary compound $6LiF \cdot BeF_2 \cdot ZrF_4$, which crystallizes as the primary phase from the MSRE fuel, was isolated. Crystal-property data derived for the ternary compound indicated that neither ThF_4 nor UF_4 is included in crystals of $6LiF \cdot BeF_2 \cdot ZrF_4$ as it precipitates from molten $LiF-BeF_2-ZrF_4-ThF_4-UF_4$ mixtures. Continuing studies of phase behavior in the binary, ternary, and quaternary systems limiting the system $LiF-BeF_2-ThF_4-UF_4$ demonstrated that melt compositions containing up to about 7 mole % UF_4, ZrF_4, and ThF_4 will remain liquid at temperatures as low as approximately 450°C. Crystallization behavior below this temperature, as determined through phase equilibrium investigations, indicated that uranium will precipitate in the form of a dilute solid solution and thus will not be a serious criticality problem. Characterization of the solid phases formed on cooling the molten-fluorides facilitates identification of the phases produced in various experiments and has made possible accurate predictions of phase behavior under off-design condition as, for example, in recent in-pile tests of MSRE materials. (auth)

26789 (TID-7641(p.300-6)) HIGH DENSITY PLUTONIUM DIOXIDE MICROSPHERES FOR A REACTOR FUEL. L. V. Jones, Donald Ofte, P. A. Tucker, and L. J. Wittenberg (Mound Lab., Miamisburg, Ohio).

Plutonium oxide was prepared in the form of thermally and chemically stable microspheres in an induction-coupled plasma torch. The microspheres exhibited a remarkable freedom from loose contamination making applications feasible that were previously unattractive because of the hazards normally associated with the handling of plutonium oxide. The microspheres were produced by passing PuO_2 particulates through an inductively-coupled plasma torch. The feed material was produced by die pressing chemically produced plutonium oxide powder, sintering the pressed pellets at 1450°C in air for 1 hr, and grinding the fired pellets to a preselected sieve size. The microspheres were produced in discrete size fractions from 15 to 250 μ in diam. Prepared batches of feed material were introduced into the upper region of the plasma at a slow uniform rate. The particulates falling through the plasma were heated above their melting point and assumed a spheroidal shape which they retained on solidifying after leaving the plasma. The microspheres were characterized by x-ray diffraction, microhardness testing, density measurements, leach tests, and alpha survey wipes. The PuO_2 in the form of microspheres had a face-centered cubic structure with a unit cell size of 5.395 ± 0.002 A. This value compared favorably with the accepted unit cell size for stoichiometric PuO_2 of 5.396 ± 0.001 A as reported in the literature. The preservation of stoichiometry is significant as compared to the oxygen deficient species found by all previous investigators in the material remaining after melting PuO_2. Leach tests made on the microspheres in several acid, neutral, and alkaline media showed no evidence of solubility of the particulates. Density measurements made on the microspheres by two different techniques indicated an average density of 11.0 g/cc, 96% of theoretical crystalline density. Microhardness measurements on the solid crystalline PuO_2 indicated an average Vickers hardness of 1163 kg/mm^2. The PuO_2 microspheres showed an absence of loose contamination. For example, a typical particle 0.189 mm in diam gave an emission of 368,000 counts/min; a wipe made on this particle showed absolutely no transfer of activity from the particle to the wipe. The material manifested such a "clean" character that it can be handled safely not only in an open fume hood but even in an open room instead of requiring a tightly sealed glove box enclosure. Protective devices such as respirators, which normally must be employed in handling PuO_2, proved to be unnecessary. The freedom from loose contamination, high density, chemical inertness, and thermal stability of stoichiometric PuO_2 microspheres make this material attractive for reactor fuel applications. (auth)

26790 (TID-7641(p.307-19)) STUDIES OF URANIUM(IV) NITRATE. R. DeLeone, G. Cogliati, L. Lorenzini, and R. Lanz (Italy. Comitato Nazionale per l'Energia Nucleare, Rome).

A method was developed for preparing solutions of uranium(IV) nitrate by catalytic hydrogenation of uranyl nitrate solutions. This method made it possible to prepare very pure solutions of uranium(IV) nitrate containing only uranium(IV) nitrate in dilute nitric acid, with a uranium(IV) content less than 10^{-5} moles/liter. The only catalyst found to be effective is platinum. The reduction can be carried out both in water and in an organic solvent. The hydrogenation of aqueous solutions of uranyl nitrate was carried out in three ways: first, by adding chloroplatinic acid to the solution and bubbling in hydrogen at normal pressure; second, by passing in equicurrent with the solution hydrogen under a pressure of 20 atm in a column packed with platinum-coated alumina pellets; and third, by adding urea and formic acid and passing the heated solution on the catalyst. The kinetics of these three reactions were investigated. The reduction in an organic solvent was carried out discontinuously in an autoclave under pressures up to 50 atm. In this case, two moles of free nitric acid per mole of uranium to be reduced must be present; in water, on the contrary, if less than 2 moles are present, hydrolyzed uranium(IV) ions are formed. This hydrolysis, which is slowly reversed upon addition of nitric acid, can play an important role in determining the properties of the reduced solutions, which, in this case, are also scarcely reproducible. In water, solutions containing up to 3 moles of free nitric acid per liter were reduced. Distribution of uranium(IV) nitrate between dilute nitric acid and TBP and equilibration with anion-exchangers showed a marked formation of anionic complexes for concentrations of free nitric acid of more than 2 moles/liter. The main property of uranium(IV) nitrate is its instability. The decomposition of uranium(IV) nitrate was thoroughly investigated only at room temperature and for dilute solutions (0.01 molar), which upon reduction did not undergo hydrolysis. In this case, the main products are uranyl nitrate and nitrous acid. The reaction between uranium(IV) ions and nitric acid is catalyzed by nitrous acid (a similar catalytic action of nitrous acid in the air oxidation of uranium(IV) perchlorate was also found) and does not occur in the absence of it. Therefore, the beginning of decomposition can be delayed by adding some compound, like urea, which destroys nitrous acid before it can start decomposition. The presence, or bubbling in, of air can also slow down the beginning of the reaction. In an inert atmosphere the reaction is initiated by the nitrous acid which is formed at equilibrium with nitric acid in the presence of uranium(IV). The amount and the formation rate of this nitrous acid is dependent on nitric acid concentration, which, in this way, has some influence on the starting phase of the reaction. Kinetic studies showed that the reaction is first order in uranium(IV) and half order in nitrous acid; its dependence on nitric acid concentration, once started, is small. Nitrous acid itself reacts very slowly or does not react at all with uranium(IV); it can react upon decomposition, but this contribution to the oxidation of uranium(IV) for the solutions considered is not important. (auth)

26791 (TID-7641(p.326-50)) CONDITIONING CARBON–STEEL–WATER SYSTEMS. H. K. Rae and E. Yatabe (Atomic Energy of Canada Ltd., Chalk River, Ont.).

The effect of temperature and surface condition on the initial release of crud by carbon steel and the resulting crud concentrations in the water are described. This information was used to specify the procedure for conditioning the carbon steel primary circuit of the Nuclear Power Demonstration Reactor at Rolphton, Ontario. This conditioning period preceded fuel loading, and was required to reduce the crud concentration to less than 0.5 ppm before fuel could be placed in the core. These experiments were made in a small stainless steel out-reactor loop. An area of carbon steel equal to one-third of the total loop area was added at the start of each test. Samples of carbon steel were used to measure total cor-

rosion and the fraction of corrosion product released to the water. Corrosion rates were estimated from the rate of accumulation of hydrogen in the loop. Crud deposition on samples of other metals was also measured. Experiments were made at 40, 95, 150, 205, and 260°C using both clean and rusted carbon steel. Over the range 95 to 260°C there was not a large effect of temperature, although the initial corrosion rate did increase with increasing temperature. The release of corrosion product (Fe_3O_4) to the water was 10% of the total corrosion for exposure periods of a few hundred hours, but tended to be much lower after longer periods. This material did not remain in the water, but deposited on other loop surfaces, mainly stainless steel. The initial crud concentration in the water was about 1 ppm, but decreased to less than 0.05 ppm within 30 to 50 hr. This rapid decline in crud level was only slightly affected by the rate of water purification. In fact, fairly rapid decline in crud concentration occurred in the absence of purification. Since the maximum coolant temperature that could be obtained conveniently in the NPD reactor without nuclear heat was 180°C, further tests at a somewhat lower temperature (150°C) were made. These confirmed that low crud levels were quickly attained, an adherent magnetite film was formed on the steel, and subsequent heating to 260°C caused only a brief crud burst. The crud levels observed with rusted steel were only slightly higher than those obtained with clean steel. The behavior of crud during the startup of the NPD reactor was very similar to the results obtained with the loop. After the initial conditioning period prior to loading the fuel, the crud concentration in the NPD primary circuit was 0.05 ppm. A discussion of some possible mechanisms for iron transport in circuits of this type is included. (auth)

26792 (TID-7641(p.353-66)) HYDRIDING OF ZIRCONIUM-BASE ALLOYS DURING EXPOSURE TO CIRCULATING AQUEOUS THORIA AND THORIA–URANIA SLURRIES. S. A. Reed, W. J. Leonard, E. L. Compere, and L. Rice (Oak Ridge National Lab., Tenn.).

A toroid test program was conducted to study variables associated with hydriding of zirconium alloys during exposure to circulating aqueous slurries of ThO_2 and thorium-uranium oxides. It was concluded that the rate and extent of hydriding of zirconium and zirconium-base alloys during exposure to circulating aqueous thoria and thoria-urania slurries at 200, 280, and 330°C were primarily dependent upon the type and overpressure of the gaseous atmosphere. Thus hydriding did not occur in toroids under oxidizing atmospheres, and, for example, did not occur in the presence of dissolved hydrogen or oxygen when the specimens were continuously immersed in slurry in a dynamic loop. The alternate fluid and gas exposure caused by the slug flow in a toroid was important in promoting hydriding. Other significant factors were temperature, flow velocity, exposure time, slurry type, and hydrogen pressure. The temperature effect seemed to be maximum at about 280°C, with less hydriding observed at 330°C and none at 200°C. The rate and severity of hydride formation increased with flow velocity, exposure time, and hydrogen pressure. Also, increased uranium/thorium ratio drastically increased hydriding; Zircaloy-2 exposed to a slurry containing an oxide with U/Th = 0.13 under 100 psi D_2 pressure hydrided catastrophically in 300 hr at 280°C. Reaction of hydrogen with the alloys was initiated at localized areas of bare metal which resulted from erosion of surface film by the slurry. Hydriding progressed due to intergranular diffusion of hydrogen. Depending on conditions, the gaseous hydrogen as well as hydrogen from corrosion could participate in the hydride formation. Of the conventional alloys, coarse-grained Zircaloy-2 was most susceptible to hydriding. Fine-grained Zircaloy-2 and Zircaloy-3 were moderately hydrided. Only localized areas of zirconium hydride needles were observed in Zircaloy-4 and pure zirconium. Experimental binary alloys of zirconium with palladium (1 and 0.1%) were grossly hydrided; similar alloys with platinum were only moderately hydrided. The alloy Zr–15% Nb was not detectably hydrided, although it was severely eroded under hydrogen atmosphere. (auth)

26793 (TID-7641(p.367-89)) PWR CHEMISTRY STUDIES OF THE ORR IN-PILE LOOP. C. F. Baes, Jr. and T. H. Handley (Oak Ridge National Lab., Tenn.).

There are two important unsolved problems associated with the water chemistry of pressurized water reactor primary systems: the transport and deposition of corrosion products (crud), which foul heat transfer surfaces and impair the operating reliability of mechanical systems exposed to primary water, and the transport and deposition of long-lived activities (originating from the activation of corrosion products in the reactor flux), causing a long term buildup of radiation levels throughout the primary system. In undertaking a study of the water chemistry of the ORR pressurized water loop, the primary objective was to gain an increased knowledge of the nature and behavior of water-borne activity and crud in the hope that new methods for their control would be suggested. Results obtained thus far provide strong evidence that in this neutral pH–PWR system a large part of the low-level, longer-lived, water-borne activity during normal loop operation (principally Mn^{54}, Fe^{59}, Co^{58}, and Co^{60}) is present as dissolved ionic material. Thus tests in which cooled water samples were passed through a series of decreasing-porosity Millipore filters showed a lower limit to crud particle size of $\sim 0.5\ \mu$, virtually all remaining water-borne activity passing through a $0.01\ \mu$ filter. This "nonfilterable" activity was absorbed reversibly by cellulose backing pads used in some filtration tests. Such activity, when absorbed on chromatographic paper, was found in electromigration tests to move toward the cathode with a velocity expected for simple cations. Finally, assuming the same specific activity for the dissolved material as was found for the filterable crud, the resulting concentration of ionic material, calculated on the assumption that all the nonfilterable activity is present as simple ions, was in reasonable agreement with the ion concentration indicated from observed loop water conductivity. Other results suggest, further, that the dissolved activity exchanges at an appreciable rate with the crud activity. This crud was found from electronmicrographs to be crystalline in appearance and from x-ray diffraction patterns to exhibit the structure of magnetite, often found to be a principle constituent of PWR crud. The apparent lower limit to particle size suggests that recrystallization occurs. The previous assumption of equal specific activities for the dissolved material and the crud was consistent with such exchange. Since magnetite (Fe_3O_4) in the stable oxide of iron in such systems, and a principle constituent of crud, it suggests itself as a possible high temperature filter ion-exchange medium. If, as is suggested here, this constituent of crud both supplies and exchanges with the ionic material in the high-temperature water, then the introduction of a bed of nonactivated magnetite into a neutral pH–PWR coolant system might well, by the same

process which contributes to the transport of activity, accumulate the dissolved activity without otherwise disturbing the chemical or nuclear behavior of the system. Accordingly, tests are in progress to examine the suitability of magnetite as such a high-temperature purification medium. (auth)

26794 (TID-18727) NEW HYDRAULIC CONTROL ROD ACTUATOR FOR LARGE NUCLEAR REACTORS. (American Bosch Arma Corp. American Bosch Div., Springfield, Mass.). Mar. 28, 1963. Contract AT(30-1)-2932. 7p.

A hydraulically operated control rod actuator was developed for use with large water-cooled reactors. It is capable of actuating control rods weighing up to 2300 pounds. Pressurized primary reactor water is used as the hydraulic fluid, and the design provides smooth, accurate positioning of the control rod with zero drift and a rapid scram response. The transmission of low-level command signals and rod position signals is accomplished by the use of magnetic field coupling through the pressure wall. (M.C.G.)

26795 NEUTRON CHAIN REACTION WITH FAST NEUTRONS. Ivo Marek (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Apl. Mat., 8: 102-17(1963).

The possibility of a sustained neutron reaction in a given slab medium containing a mixture of U^{238} and U^{235} dependent on a given parameter and reactivity was studied. It was proved that the criticality of the medium is directly dependent on each parameter. The existence or nonexistence of the solution and the uniqueness of critical parameters in case of its existence is the result of the above fact. The examination is based on an application of functional-analytic methods in Banach's space with a cone of positive elements. Theorems that possess a significance of their own without being dependent on the problems solved are also discussed. (P.C.H.)

26796 THE EFFECT OF SINGLE CHANNELS AND SLITS ON THE REACTIVITY. Ya. V. Shevelev. At. Energ. (USSR), 14: 364-70(Apr. 1963). (In Russian)

The effect of cylindrical and flat occlusions, with transport cross sections Σ'_{tr} differing from that of the surrounding medium, on reactivity was investigated. The change of the reactivity is indicated by perturbations in the neutron flux at a certain distance from the occlusion, where the diffusion approximation is valid. Using the flux calculations in the laminar medium and near the cylinder, the reactivity changes may be correlated with the characteristics of the occlusion, such as the transport cross section, volume, shape, position, etc. The effect of the shape is indicated by the divergence of the coefficients $B_{||}$ and $B_{\perp}$ from unity; the same coefficients control the value of the averaged diffusion coefficients, $D_{\perp}$ and $D_{||}$. An interpolation formula was derived for calculating the value of $B_{\perp}$. (TTT)

26797 A METHOD FOR CALCULATING THE NEUTRON FLUX IN A SHUTDOWN REACTOR WITH A PHOTONEUTRON SOURCE. L. V. Konstantinov and B. I. Kochetov. At. Energ. (USSR), 14: 402-4(Apr. 1963). (In Russian)

Subcritical neutron flux measurements in a shutdown reactor are rendered difficult by the radiation of the fission products; artificial neutron sources are used to increase the neutron flux to the level required by the instrumentation. In order to eliminate the expensive Po – Be sources the use of photoneutron sources containing Be or heavy water is considered, employing Na^{24}, Sb^{124}, etc. as the γ source. The decay of the source after the shutdown of the reactor is compensated by its activation by thermal neutrons during the subsequent operation of the reactor. The negative reactivity thus introduced must be compensated by a (γ,n) reaction. A method was developed for calculating photoneutron sources with a γ source consisting of the fission fragments formed during the operation of the reactor. The method also allows the calculation of photoneutron sources using radioactive isotopes, taking the relative positions of the Be and γ emitter into consideration. The neutron flux in the core is determined by solving the eigenfunctions of the reactor. From these the required reactor power level and Be concentration may be obtained. The validity of the formula was verified with the First Soviet Atomic Power Station. Before startup at the subcritical state $\Delta k = 0.093$ an 8 kg BeO rod was introduced in the central lattice, resulting in an increase of the flux by a factor of 2.3 to 2.5. The calculated and experimental values agreed with each other within 10%. (TTT)

26798 A RADIATION CHEMICAL RESEARCH FACILITY IN THE BEAMHOLE OF THE IRT-2000 REACTOR. A. A. Akhundov, G. S. Karumidze, G. M. Krasavtsiva, and V. T. Popov. At. Energ. (USSR), 14: 412-14(Apr. 1963). (In Russian)

During February 1962, the operation of a circulating loop, installed in the IRT-2000 reactor core at the Physical Institute of the Georgian Academy of Sciences was started for carrying out radiochemical investigations in gaseous, vapor, and liquid phases at temperatures ranging from 40 to 600°C and at pressures from 1 to 30 atm. The possibility of increasing the vapor pressure of the materials under study is a feature of this facility. The temperature and pressure prevailing within the system are automatically controlled; samples are also removed by automatic operation. Up to now 88 radioinduced cracking tests were completed with hydrocarbons. Liquids may be added at a desired rate within 50 to 3000 ml/hr. Stainless steel pipes were used for fabricating the reaction portion of the system; duralumin rods, supplemented by paraffin and Pb blocks served for the preparation of the biological shield. The whole system operated very reliably. (TTT)

26799 THE STABILITY OF A SUSPENSION REACTOR. H. Hejtmanek (Osterreichische Hochschule, Vienna). Atomkernenergie, 8: 166-8(May 1963). (In German)

If the circulating pump of a suspension reactor stops, the suspended particles begin to sink and the criticality goes up. Using the diffusion approximation, it can be shown that this behavior is inherent to a suspension reactor. But it is possible to give a condition for the reactivity peak to become small. (auth)

26800 THE MULTIPURPOSE RESEARCH REACTOR (MZFR). J. Brandl. Atomwirtschaft, 8: 257-9(Apr. 1963). (In German)

The design of the 50-Mw(e) multipurpose research reactor (MZFR) is described. In addition to the generation of electric power it will also permit the serial testing of fuel elements under power station conditions, the irradiation of reactor materials, and the production of radioisotopes. The relation of the reactor to the nuclear research center, the total installation, and the experimental apparatus and program are discussed. (M.C.G.)

26801 THE MEASUREMENT OF LOW REACTIVITIES BY SOURCE MODULATION. Constantin Kassimatis, Maurice Surdin, and Jacky Weill. Compt. Rend., 256: 3456-8(Apr. 17, 1963). (In French)

A very fast and relatively precise method for the measurement of the reactivity of a subcritical reactor is described. (tr-auth)

26802 A SIMPLIFIED MODEL FOR THE DETERMINATION OF THE THERMAL NEUTRON SPECTRUM IN A FUEL ELEMENT. A. Kind and G. Rossi (C.C.R. Euratom, Ispra, Italy). Energia Nucl. (Milan), 9: 628-34(Nov. 1962). (EUR-260.e) (In English)

A simplified model is proposed to evaluate the thermal neutron spectrum in a fuel element, which contains some moderating materials. Although this problem is a complex one, it can be solved at least in first approximation by simple methods, provided the hardening of the spectrum due to the selective absorption in the fuel and the rethermalization due to the interaction with the moderating materials are treated separately. The methods used to evaluate separately these effects are presented, and a way to bring their results together is proposed. An application of the model to a cell, for which hot loop experiments were performed, is presented and discussed. (auth)

26803 ON THE THEORY OF SPACE DEPENDENT NEUTRON SPECTRA IN HETEROGENEOUS REACTORS. Helmut Kunze (Kernforschungszentrum Karlsruhe, Ger.). Nucl. Sci. Eng., 15: 1-12(Jan. 1963).

An analytical method is developed for determining the energy dependent neutron flux in homogeneous and heterogeneous media. Using the heavy gas model scattering operator, neutron spectra in two-dimensional rod reactors of various types are calculated in the diffusion approximation. They show a strong spatial dependence even in the epithermal region, which fact is neglected in the numerical treatment of the problem by Honeck and Kaplan. It is just this epithermal part of the spectrum, which mainly influences the values of the thermal utilization and the η-factor. The value obtained for the latter quantity is too large if the correct neutron spectra in moderator and fuel are replaced by Maxwellian distributions at moderator-temperature or a suitably displaced temperature, for example. (auth)

26804 THE THERMAL UTILIZATION AND FLUX RATIOS IN COMPLEX LATTICES. A. Pazy (Israel Atomic Energy Commission, Tel Aviv). Nucl. Sci. Eng., 15: 29-36(Jan. 1963).

The calculation of the thermal flux in the moderator of a supercell containing several fuel and control elements is considered. It is assumed that the one group diffusion equation with a constant source holds in the moderator. It is further assumed that the absorption of thermal neutrons in fuel rods (or control rods) may be described as due to a cylindrically symmetric line sink. With these assumptions the diffusion equation is solved and a general expression for the thermal flux in the moderator is obtained. This expression is then used to calculate the thermal utilization in the supercell, and the ratios of absorption rates in the different elements of the lattice. General expressions for the flux ratios and thermal utilization are obtained. By way of illustration, solutions of two typical cases of complex lattices are given. (auth)

26805 DANCOFF CORRECTION FOR SEVERAL INFINITELY LONG CYLINDRICAL RINGS. G. Velarde (Junta Energia Nuclear, Madrid). Nucl. Sci. Eng., 15: 99-102(Jan. 1963).

Calculations were made for the Dancoff correction for resonance neutrons in several infinitely long cylindrical rings of fuel and moderator. The resulting equations are $C_{ji} = (r_{j0}/r_{ji})B(\Sigma_j r_{j0}, r_{ji}/r_{j0})$ and $C_{j0} = A(\Sigma_j r_{j0}, r_{ji}/r_{j0}) + B(\Sigma_j r_{j0}, r_{ji}/r_{j0})$. The functions A and B were numerically calculated and are presented graphically. (D.L.C.)

26806 ELEMENTARY METHODS OF REACTOR NOISE ANALYSIS. Joseph A. Thie. Nucl. Sci. Eng., 15: 109-14 (Feb. 1963).

The analysis of reactor power fluctuations has proved useful for many reactors. Limited analysis techniques giving specific noise characteristics are proposed. Utilizing the Gaussian property of reactor noise, simplified methods of obtaining the standard deviation are given. The concepts of the easily evaluated correlation times and moments of the power spectral density are applied in the noise analysis of several boiling reactors. It is shown that standard deviations of filtered reactor noise can give spectral shape information. Finally, simplified analysis of narrow band spectra is discussed with regard to obtaining the resonance width. (auth)

26807 BEHAVIOR OF IODINE AND XENON IN THE HOMOGENEOUS REACTOR TEST. William D. Burch and Lawrence B. Shappert (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 15: 124-30(Feb. 1963).

The behavior of iodine and xenon was studied during the experimental program of the Homogeneous Reactor Test to evaluate the various methods proposed for removal of these fission products to reduce the biological hazard of iodine and minimize xenon poisoning. The observed retention of both iodine and xenon in the reactor high-pressure system considerably altered design removal concepts. Only 10 to 25% of the iodine in the high-pressure system circulated with the fuel solution, and xenon, formed by decay of iodine adsorbed on the walls, was retained on the walls up to 10 hr before diffusing back into the circulating stream. The xenon poison fraction was found to be 0.010 at full power of 5 Mw. (auth)

26808 AT-POWER, LOW-FREQUENCY, REACTOR-POWER-SPECTRUM MEASUREMENTS AND COMPARISON WITH OSCILLATION MEASUREMENTS. C. W. Griffin and R. L. Randall (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 15: 131-8(Feb. 1963).

Power spectral density measurements were conducted at the Sodium Reactor Experiments (SRE) over a wide range of frequencies and at various power levels. Use of magnetic tape recording and speedup techniques permitted rapid data analysis and excellent resolution. Results were compared with oscillation tests under identical operating conditions and were found to have the same resonance structure but higher amplitude at the resonance peaks and at low frequencies. Investigation resulted in the conclusion that the reactor fission or driving spectrum deviated from white noise at some low frequency. (auth)

26809 LINEAR STABILITY OF THE THERMAL FLUX IN A REFLECTED CORE CONTAINING XENON AND TEMPERATURE REACTIVITY FEEDBACK. Louis M. Shotkin and Frederick H. Abernathy (Harvard Univ., Cambridge, Mass.). Nucl. Sci. Eng., 15: 197-212(Feb. 1963).

The stability of the thermal flux in a reflected slab reactor due to xenon and temperature reactivity feedback is investigated using perturbation theory. A reactor with spatially constant fuel, equilibrium flux, and materials in the core is examined under various reactivity feedback situations. Stability criteria are given along with associated oscillation periods for the condition of neutrally stable equilibrium, i.e., continuous oscillation of the perturbed flux. The conditions for interaction of the xenon and temperature reactivity feedback are shown for both long and short temperature delay; the effect of delayed neutrons being considered when appropriate. A cosine fuel distribution is found to be necessary to give spatially constant equilibrium

flux and this cosine fuel model is shown to predict slightly more stable conditions than the flat fuel model. Coupling of the first two (even or odd) excited modes is shown to occur (for a constant power density model) in large, high flux reactors, leading to more unstable conditions than with no coupling. (auth)

26810 THE MEASUREMENT OF THE LATTICE PARAMETERS OF A GAS COOLED REACTOR LATTICE. P. F. Nichols, J. R. Worden, F. C. Engesser, and R. E. Heineman (General Electric Co., Richland, Wash.). Nucl. Sci. Eng., 15: 233-44 (Mar. 1963).

A series of experimental measurements was made on the Experimental Gas Cooled Reactor (EGCR) lattice in the Physical Constants Test Reactor (PCTR). The measurements provide a broad basis for normalization of reactor calculations for lattices of this type. The fuel assembly is a cluster of seven uranium oxide rods, enriched in the U^{235} isotope and clad with stainless steel. The fuel is spaced on an eight-inch square pitch in a graphite moderator. Values of the lattice parameters k_∞, f, p, and ϵ were obtained for 1.8% enrichment of the uranium oxide fuel. The values of k_∞ and f were also obtained for 2.6% enrichment fuel. The techniques of using the PCTR were extended so that supercell measurements may be made. The values of the strength of a boron carbide control rod and a stainless steel loop tube were obtained in this way. The strength of such an inhomogeneous poison in the lattice is expressed as the difference in the supercell multiplication factor k_∞ with and without the poison in the supercell. This difference is the same quantity which is obtained in the usual reactor cell calculation. The fuel temperature coefficient of k_∞ for this cluster was also measured between 50 and 500°C. The coefficient obtained is temperature dependent. The more important of the lattice parameters for the 1.8% enriched fuel are $k_\infty = 1.146 \pm 0.004$, $f = 0.809 \pm 0.005$, $p^{28} = 0.824 \pm 0.006$, $\epsilon = 1.019 \pm 0.002$, Δk (control rod –16 cell supercell) $= -0.157 \pm 0.012$, Δk (empty loop tube –9 cell supercell) $= -0.117 \pm 0.011$, and $(1/k_\infty)(dk_\infty/dT) = -(0.68 \pm 0.05) \times 10^{-3} T^{-1/2}(°K)^{-1}$. For the 2.6% enriched fuel, results are $k_\infty = 1.256 \pm 0.009$ and $f = 0.845 \pm 0.006$. (auth)

26811 A METHOD FOR THE ACCURATE DETERMINATION OF RELATIVE INITIAL CONVERSION RATIOS. P. R. Tunnicliffe, D. J. Skillings, and B. G. Chidley (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 15: 268-83(Mar. 1963).

An experimental method of determining "initial conversion ratios," the number of Pu^{239} atoms produced for each U^{235} atom destroyed, is described. The measurements are made relative to the conversion ratio that would be obtained for thin uranium in a thermal flux. The precision is about $\pm\frac{1}{2}$%. The relative neptunium and fission product activities induced in a representative cross section of the fuel material (a thin foil of natural uranium) and in a foil in a thermal flux are compared. The neptunium is counted by a coincidence method which suppresses the counting rate due to fission products and natural background 10 times relative to the neptunium counting rate. (auth)

26812 XENON POISONING IN A SHUT-DOWN REACTOR. H. Albers (Federal Inst. for Reactor Research, Würenlingen, Switzerland), Z. J. Doron, W. Haelg, and S. Ravani. Nucl. Sci. Eng., 15: 342-4(Mar. 1963).

The method of calculating an effective flux for the whole reactor was used to calculate the xenon buildup and decay after shutdown. A xenon run was made in the Diorit reactor, in which xenon was first allowed to build up at a power of 17.6 Mw and the power then reduced to 0.16 Mw. The measured reactivity invested in xenon was in good agreement with the theoretical predictions. (D.L.C.)

26813 DESIGN OF A SMALL AQUEOUS HOMOGENEOUS BREEDER REACTOR. R. H. Chapman, I. Spiewak, M. L. Tobias, and D. R. Vondy (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 15: 347-53(Apr. 1963).

The design of a small experimental breeder reactor which it is believed will not be subject to the chemical difficulties characteristic of the HRE-2 is presented. The reactor simulates in a small size the nuclear, chemical, mechanical, and hydrodynamic characteristics believed typical of large reactors of this type. The simulation is made possible largely by the use of a beryllium reflector between the uranyl sulfate solution core and the thoria pellet fertile blanket. The nuclear calculations indicate an initial gross breeding ratio of 1.07 for a completely blanketed reactor fueled with U^{233}. (auth)

26814 NEUTRON TEMPERATURE DISTRIBUTIONS IN A CYLINDER OF HOT MODERATOR. C. B. Bigham, R. B. Turner, and B. G. Chidley (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 16: 85-100(May 1963).

Relative reaction rates in selected nuclides were measured through the central lattice cell of ZEEP with the fuel cluster replaced by a pressure tube containing different mixtures of light and heavy water. The surrounding heavy water moderator was at room temperature. Measurements were made with the pressure tube filled with air and four mixtures ranging from reactor grade heavy water to light water, at temperatures up to 280°C. The radial variations are given for the reaction rates, which were measured, and for the effective neutron temperature T and the epithermal index $r\sqrt{T/T_0}$, deduced from the reaction rates. (auth)

26815 REACTOR DYNAMICS WITH REACTIVITY LOSS RATE PROPORTIONAL TO ENERGY. J. Ernest Wilkins, Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 16: 135-7 (May 1963).

An analysis is made of the differential equation for the dynamics of a reactor with an accidental excess reactivity and a control mechanism which removes reactivity at a rate proportional to the energy. The analysis is based on the fluid dynamics problem of laminar flow over a flat plate when blowing or suction occurs. The results are plotted on a dimensionless graph of the time at which the reactor becomes critical again, the maximum power, and the energy. Series expansions of the variables are also derived. (D.L.C.)

26816 THE CONCEPT OF REACTIVITY AND ITS APPLICATION TO KINETIC MEASUREMENTS. T. Gozani (Institut für Reaktorforschung, Würenlingen, Switzerland). Nukleonik, 5: 55-62(Feb. 1963). (In English)

The kinetic eigenvalues, which are unique and in principle measurable, can be related in a consistent manner to any desirable definition of reactivity. This arbitrariness in the concept of reactivity is caused by an arbitrary weighting of the neutron population. Among the many possible weight-functions three are shown to merit special attention: the kinetic function, the static function, and the dynamic weight function. The important role played by the static reactivity, its meaning, and its special properties are discussed. Applying the tractable multigroup model, it is demonstrated that a characteristic feature of delayed neutrons is their closely spaced spectrum of eigenvalues and correspondingly similar eigenfunctions ("sub-modes").

The possible deviation of the prompt neutron sub-mode from the main mode is emphasized. The dependence on the reactor configuration of the generation time of neutrons distributed in the prompt sub-mode, which is an essential quantity for pulsed-neutron experiments, is discussed. It is shown that a nonnegligible difference exists between this generation time and that of the persisting mode, especially in heavy water reactors. (auth)

26817 A SOLUTION OF THE KINETIC EQUATIONS IN PERIODIC REACTIVITY CHANGES. A. Fraude (Kernforschungszentrums, Karlsruhe, Ger.). Nukleonik, 5: 62-7 (Feb. 1963). (In German)

A solution of the kinetic equations of a reactor with periodic reactivity pattern is given. It was developed from the solution of the linearized form of this equation. The occurrence and the magnitude of the exponential increase of the neutron density are explained using this solution. (tr-auth)

26818 MEASUREMENTS OF NATURAL URANIUM-HEAVY WATER LATTICES BY THE PULSED NEUTRON TECHNIQUE. Fredrick Robert Westfall. Thesis, Raleigh, N. C., North Carolina State Coll., 1962. 82p.

Natural U lattices in heavy water were investigated with the pulsed-neutron-source method. The systems were very small; buckling ranged from 300 to 900 m^{-2}. In the experiments, the mean life of the decay of thermal neutrons in systems of well-defined geometry was measured as a function of buckling. From a least-squares fit of the derived expression for the decay constant to the experimental data, quantitative information was obtained regarding the diffusion and lattice parameters characteristic of the system. Three sets of measurements were run in both of 2 different-sized cylindrical tanks; heavy water, lead-mercury stacks in heavy water, and U rods in heavy water. This enabled an extension of the range of bucklings and the investigation of two lattices of particular interest: a single rod centrally located in a small test volume and a triangular array of rods on a 7-inch pitch in a larger container. By observations and analysis on this sequence of 3 media, the important parameters for a multiplying system were deduced. (Dissertation Abstr.)

26819 DEVICE FOR AUTOMATICALLY FILLING SAFETY WATER SEALS OF NUCLEAR REACTORS. J. Schierenbeck (to Kernreaktor Bau- und Betriebsgesellschaft mbH). German Patent DAS 1,145,278. Mar. 14, 1963. Filed Dec. 30, 1959.

The safety water seal is for preventing the pressure within the reactor vessel rising above or going below a given value. If the pressure within the reactor vessel is lower than the safe value the deflection water basin of the seal will be emptied and air will pour into the reactor vessel via the seal, causing the pressure to rise again. After a given time or after reaching the given pressure value, the seal has to be closed again by filling up automatically the deflection basin. This can easily be achieved by locating a water basin above the safety water seal within which there is a floating body, this floating body being lowered when the deflection basin is emptied thus opening a valve which normally closes the water inlet tube in the basin. (Gmelin Inst.)

26820 NUCLEAR REACTOR WITH CONTROL RODS, WHICH ARE TO BE MOVED INTO A SHUT-DOWN POSITION BY PROPULSION DEVICES. Antony J. Taylor (to Deutsche Babcock & Wilcox-Dampfkessel-Werke AG). German Patent DAS 1,146,597. Apr. 4, 1963. Priority date Sept. 4, 1957, Great Britain.

A nuclear reactor is described which has at least one control rod which can be moved into a shut-down position by a scramming device. The moment the control rod has reached its shut-down position it is grabbed by a latch mechanism. This latch mechanism fixes the rod in its shut-down position independent of the fast acting scramming device. A detailed description of the latch mechanism is given. (Gmelin Inst.)

26821 NEUTRON-ABSORBING MATERIAL FOR CONTROLLING THE REACTIVITY OF NUCLEAR REACTORS. Christoph Steiner (to Deutsche Babcock & Wilcox-Dampfkessel-Werke). German Patent DAS 1,146,987. Apr. 11, 1963. Filed Apr. 4, 1960.

A neutron-absorbing material is given, e.g., in a gaseous phase, which can be either added to the reactor coolant or can be inserted into the core separately. This material is composed of substances which are transformed by neutron capture into highly effective neutron-absorbing substances. The concentration of the substances is proportioned so that the concentration of the neutron-absorbing daughter products has a constant value. Bromine, selenium, and tellurium are suggested as useful substances. (Gmelin Inst.)

26822 WINDING SYSTEM FOR RAISING AND LOWERING A CONTROL ROD IN A NUCLEAR REACTOR. Thomas Caril Greaves (to English Electric Co., Ltd.). German Patent DAS 1,146,988. Apr. 11, 1963. Priority date Feb. 10, 1959, Great Britain.

A winding system for raising and lowering a control rod is described which consists of two drums with parallel axes and a flexible winding cable which is wound several times from one drum to the other, one end of the cable being attached to the winding case and from the other end of which the control rod is suspended. Movement of the control rod relative to the reactor core is achieved by varying the distance between the axes of the two drums. (Gmelin Inst.)

26823 NEUTRON SHIELDING FOR NUCLEAR REACTORS. Everett Long and Jack Jones (to United Kingdom Atomic Energy Authority). U. S. Patent 3,086,931. Apr. 23, 1963. Priority date June 24, 1957, Great Britain.

An improved neutron-shielding device is patented for nuclear reactors. In a reactor with a shield adjacent to the core and vertical control-rod channels, tubes of neutron-shielding material are extended in a direction away from the core around the control-rod-access holes in the shield. The tubes are terminated in neutron-shield plugs, thereby reducing neutron leakage around the control rods. (M.P.G.)

26824 FUEL ELEMENTS FOR NUCLEAR REACTORS. Ian Hugh Morrison (to United Kingdom Atomic Energy Authority). U. S. Patent 3,086,934. Apr. 23, 1963. Priority date July 31, 1959, Great Britain.

A nuclear reactor fuel element consisting of a nuclear fuel member enclosed in a protective sheath is patented. The design includes Burst Cartridge Detection (B.C.D.) apparatus to detect fission products that may escape through leaks in the sheaths. Since the most likely place for a leak in this fuel-element design is at the joint between a minor part (such as an end cap) and the main body of the sheath, an insert of nuclear fuel material is placed in proximity to the joint to give an early warning of a defect. A detailed description and drawing of the design are included. (M.P.G.)

26825 NUCLEAR FUEL ELEMENT ASSEMBLY AND METHOD OF FABRICATING SAME. Henry Russell Brand (to Sylvania Electric Products Inc.). U. S. Patent 3,087,878. Apr. 30, 1963. Filed Mar. 23, 1959.

A patented process for forming a nuclear fuel element consisting of a pair of terminal plates and a plurality of nuclear-fuel cross plates is described. The cross plates are laid in preformed slots in the terminal plates. The assembly is permanently united by simultaneously closing the slots upon the edges of the cross plates by exerting pressure against the edges of the terminal plates. (M.P.G.)

26826 FUEL ARRANGEMENTS FOR USE IN NUCLEAR REACTORS HAVING VERTICAL CHANNELS. Roger Martin (to Commissariat a l'Energie Atomique). U. S. Patent 3,087,882. Apr. 30, 1963. Priority date Mar. 8, 1957, France.

A patented fuel arrangement for reactors with vertical channels is described. Each tubular fuel slug is supported on a bracket on the end of an elongated rod passing through the slug. A multiplicity of rods and brackets are vertically superimposed on one another in every channel of the reactor. Each rod and bracket combination supports those located above it and is supported by those located under it. The top of each fuel slug does not touch the bracket immediately above it, so no load is transmitted from the bracket to the slug. With this arrangement, it is possible to superimpose a large number of fuel slugs without crushing the ones at the bottom of the channel. Details of the design of the rods and brackets are described and illustrated. (M.P.G.)

26827 MEANS FOR SHUTTING DOWN NUCLEAR REACTORS. Everett Long, Frank Geoffrey, and Laurence Hack (to United Kingdom Atomic Energy Authority). U. S. Patent 3,087,884. Apr. 30, 1963. Priority date July 8, 1958, Great Britain.

A secondary shutdown device, which must operate if the normal emergency shutdown becomes inoperable, is patented. The device consists of a magazine containing a plurality of neutron-absorbing balls, which are retained in the magazine by a magnetic field. When the magnetic field is de-energized, the balls fall into tubes in the core of the reactor, thereby shutting down the reactor. After the emergency, the tubes containing the balls can be removed from the reactor core, and the balls can be returned to the magazine. Details of the design of the apparatus are described. (M.P.G.)

26828 DEVICES FOR COOLING THE CONTROL RODS OF NUCLEAR REACTORS. André Ertaud and Jacques Panossian (to Commissariat a l'Energie Atomique). U. S. Patent 3,087,885. Apr. 30, 1963. Priority Date July 22, 1958, France.

Patented cooling tubes and valves for reactor control rods are described, which regulate the flow of coolant as a function of the position of the rods in the reactor. The cross-sectional diameter of each control-rod tube increases from the inlet end, so that the control rod is in the part of the tube with maximum diameter when the rod is fully inserted in the reactor core. Coolant fluid is forced through the tubes under pressure. A valve is mounted with fixed relation to the control rod and controls the flow of coolant in the channel with respect to control rod position in the core. (M.P.G.)

26829 TEMPERATURE MEASUREMENT APPARATUS FOR A NUCLEAR REACTOR FUEL ELEMENT. John Albert Robinson (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). U. S. Patent 3,087,886. Apr. 30, 1963. Priority date Feb. 20, 1959, Great Britain.

A remote temperature-measuring device is patented, which is especially applicable to reactor fuel elements. A fuel element in a stack contains a tuned resonant circuit, the resonant frequency of which is controlled by the fuel-element temperature. An interrogating circuit contains an inductance in the core of the reactor, which inductively couples with the resonant circuit of the fuel element when the fuel element is correctly positioned. By varying the a-c in the interrogating circuit, the resonant frequency, and therefore the temperature, of the fuel element can be determined. The temperatures of a plurality of fuel elements in a stack can be measured in a similar manner by arranging the inductive couplings between resonant circuits of adjacent fuel elements so that all the resonant circuits are electrically in cascade to form a composite circuit. (M.P.G.)

26830 FUEL ELEMENTS FOR NUCLEAR REACTORS. Sydney Fawcett, Hale Barnes, and Frank Geoffrey Greenhalgh (to United Kingdom Atomic Energy Authority). U. S. Patent 3,008,897. May 7, 1963. Priority date June 24, 1957, Great Britain.

A removable fuel-containing tube for nuclear reactors is patented. The design pertains especially to reactors, such as the sodium graphite reactor, which have coolant flowing along an outer annulus of an extended vertical fuel-element channel and then reversing direction and flowing along an extended fuel-containing tube inside the annulus. The part of the fuel-containing tube that is normally occupied by the fuel is adapted to be removable with the fuel. This permits the tube to be operated at highly rated conditions, since its corrosion and wear will not have to be sustained for a longer time than the life of the fuel. The details of the design are described and illustrated. (M.P.G.)

26831 CONTROL ROD MATERIALS. Terence Stanley Busby and Mervin Wyndham Davies (to General Electric Co., Ltd.). U. S. Patent 3,088,898. May 7, 1963. Priority date Jan. 6, 1958, Great Britain.

A control-rod material is patented, which consists of a ceramic formed from boron oxide in association with one or more of the oxides of magnesium, calcium, aluminum, or silicon. The number of atoms of boron should be from 12 to 35% of the total number of atoms present in the material. Methods for forming the ceramic into suitable shapes are described. One suggested design for a control rod is a stainless-steel sleeve filled with ceramic annular cylindrical units to form a hollow rod. (M.P.G.)

26832 NUCLEAR REACTOR BURST CARTRIDGE DETECTION. David John Gibbons (to General Electric Co., Ltd.). U. S. Patent 3,088,899. May 7, 1963. Priority date Sept. 9, 1958, Great Britain.

A device to detect both slow and rapid failure of fuel elements in a fluid-cooled nuclear reactor is patented. The failures are detected by drawing samples of cooling fluid from the fuel element channels. A first monitoring device monitors at one sensitivity samples from a selected group of channels, while a second monitoring device simultaneously monitors the remainder of the channels at a lower sensitivity. A sequencing device causes the first monitoring device to monitor sequentially all of the channels in groups, while the remaining channels are being monitored by the second monitoring device. The design of the monitoring and sequencing devices are described in detail. (M.P.G.)

26833 SLURRIES FOR USE AS BREEDING MATERIALS IN NUCLEAR REACTORS. Allan Brown and John Jephson Norreys (to General Electric Co., Ltd.). U. S. Patent 3,088,900. May 7, 1963. Priority date Jan. 14, 1959, Great Britain.

An intermetallic compound of Th and Si containing substantially 66.7 at. % Si and having a hexagonal crystal structure is patented. This compound, a true β-phase of $ThSi_2$, is particularly stable in molten Bi or Bi-containing alloys, making it suitable for use as a breeding material in the form of a slurry. Methods of preparing the compound and the slurry are described. (M.P.G.)

26834 SAFETY ROD FOR LIQUID-COOLED, LIQUID-MODERATED NUCLEAR REACTOR. Axel Gerhard Vaerne Gustafsson and Per Olle Lennart Gustafsson (to Aktiebolaget Bofors). U. S. Patent 3,088,901. May 7, 1963. Filed Jan. 25, 1960.

The design of an absorption rod, which can be entirely immersed in or entirely withdrawn from a reactor tank, is patented and described in detail. The rod is secured by an electromagnet and falls of its own weight into the reactor tank when the electromagnet circuit is broken. A braking effect is achieved by D_2O in an annular region, which is forced through apertures as the rod falls. The rod is raised by increasing the pressure in the hollow piston rod, thereby forcing D_2O out of the piston rod and lifting the piston and the safety rod. (M.P.G.)

26835 ELECTRO-HYDRAULIC DRIVE FOR NUCLEAR-REACTOR CONTROL. Hermann Kumpf (to Siemens-Schuckertwerke AG). U. S. Patent 3,088,902. May 7, 1963. Priority date Feb. 17, 1959, Germany.

A device for longitudinally displacing control rods in a reactor is patented. The device consists of a displaceable hydraulic piston and an electromagnetic assembly such as the magnetic jack. The driving force is provided by the piston, and the speed of the driving motion is electromagnetically controlled. With this separation of functions, precision components are not required for the hydraulic components, and the design of the electromagnetic equipment is simplified. The design of the electrohydraulic drive is described in detail. (M.P.G.)

26836 NUCLEAR REACTOR CONTROL MEANS. Arthur Firth (to United Kingdom Atomic Energy Authority). U. S. Patent 3,088,903). May 7, 1963. Priority date Feb. 26, 1959, Great Britain.

A reactor control rod is patented, which can effect shut down when the control-rod channels are distorted by earthquakes or other disturbances. The control rod consists of a hollow casing suspended in a vertical channel by a cable. The casing is filled with discrete spherical particles of neutron-absorbing material, such as boron steel. If distortion of the control channel prevents the casing from being lowered, a plug in the bottom of the casing is released, and the neutron-absorbing particles fall into the channel, thereby contributing to shut down. In normal operation, the plug is held in place by the tension on the supporting cable. (M.P.G.)

26837 FUEL ELEMENTS FOR NUCLEAR REACTORS. David William Williams, Trevor Eyton Jones, and Eric Arthur Crouch (to United Kingdom Atomic Energy Authority). U. S. Patent 3,092,565. June 4, 1963. Priority date July 14, 1960, Great Britain.

A finned, sheathed fuel element is designed for rapid detection of any small leak in the welds of the end cap to the sheath. Grooves are provided between the inside of the end of the sheath and the end cap, and fuel inserts slightly smaller than the grooves are located in the grooves. In case of a leak, fission products from the insert have only a short path to the coolant and thence to the burst cartridge detection apparatus. (D.L.C.)

26838 APPARATUS FOR MONITORING A PHYSICAL MAGNITUDE AT A MULTIPLICITY OF DISTINCT POINTS AND IN PARTICULAR FOR DETECTING BURST SLUGS IN THE CHANNELS OF A HETEROGENEOUS NUCLEAR REACTOR. Roland Cochinal (to Commissariat à l'Énergie Atomique). U. S. Patent 3,092,819. June 4, 1963. Priority date Apr. 2, 1959, France.

An apparatus is designed for detecting when the value of a physical magnitude has reached an alarm level at any one of N points forming subgroups of n points each, such as the gaseous streams from channels in a gas-cooled reactor. Electromechanical means are used to perform the switching operations involved in controlling the sequence of gaseous samples sent to the detector. (D.L.C.)

26839 FLOW SYSTEM FOR REACTOR. Walter H. Zinn (to U. S. Atomic Energy Commission). U. S. Patent 3,093,562. June 11, 1963.

A reactor is designed with means for terminating the reaction when returning coolant is below a predetermined temperature. Coolant flowing from the reactor passes through a heat exchanger to a lower reservoir, and then circulates between the lower reservoir and an upper reservoir before being returned to the reactor. Means responsive to the temperature of the coolant in the return conduit terminate the chain reaction when the temperature reaches a predetermined minimum value. (AEC)

26840 NUCLEAR REACTOR FUEL ELEMENT. E. L. Currier, Jr. and J. H. Nicklas (to U. S. Atomic Energy Commission). U. S. Patent 3,093,566. June 11, 1963.

A fuel plate is designed for incorporation into control rods of the type utilized in high-flux test reactors. The fuel plate is designed so that the portion nearest the poison section of the control rod contains about one-half as much fissionable material as in the rest of the plate, thereby eliminating dangerous flux peaking in that portion. (AEC)

26841 COMPOSITE NEUTRONIC REACTOR. J. R. Menke (to U. S. Atomic Energy Commission). U. S. Patent 3,093,653. June 11, 1963.

This patent relates to a reactor having a core which comprises an inner active region and an outer active region, each region separately having a k effective less than one and a k infinity greater than one. The inner and outer regions in combination have a k effective at least equal to one and each region contributes substantially to the k effective of the reactor core. The inner region has a low moderator to fuel ratio such that the majority of fissions occurring therein are induced by neutrons having energies greater than thermal. The outer region has a high moderator to fuel ratio such that the majority of fissions occurring therein are induced by thermal neutrons. (AEC)

Power Reactors

Refer also to abstracts 24740, 24766, 25397, 25693, 25700, 26016, 26037, 26039, 26072, 26073, 26074, 26075, 26077, 26078, 26087, 26088, 26095, 26096, 26097, 26098, 26099, 26102, 26103, 26104, 26105, and 26106.

26842 (ACNP-62848 & Add. 1) BYRD STATION STUDY. Final Report (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C. and Allis-Chalmers Mfg. Co., Schenectady, N. Y.). Dec. 12, 1962. Includes Addendum 1. Feb. 1, 1963. Contract AT(30-1)-3111. 382p. (NYO-10493 & Add. 1).

The Army Reactor PM-3B is re-evaluated in order to have a design for application at Byrd Station, Antarctica that has reduced costs, minimized total logistics requirements, and minimized installation manpower and equipment. The revised plant conceptual design has the same 1000 kw(e) net rating as the PM-3B design. The revised plant is smaller, has less weight, less cost, and is contained in a single tunnel of uniform depth. (N.W.R.)

26843 (ANL-6669) CRITICAL STUDIES OF CORE B FOR THE ENRICO FERMI ATOMIC POWER PLANT (ZPR-III ASSEMBLY NO. 35). T. A. Doyle and A. L. Hess (Argonne National Lab., Idaho Falls, Idaho). Feb. 1963. Contract W-31-109-eng-38. 96p.

Critical studies of a simplified mockup of the second loading (Core B) for the Enrico Fermi fast reactor were made. The core consists of a fully enriched, UO_2-stainless steel cermet clad in stainless steel and cooled by sodium. The high critical mass found for the reactor mockup led to a series of experiments on reducing neutron leakage from the core by surrounding it with different reflectors. With a nickel reflector in place, measurements were made of the reactivity worths of various engineering features of the Fermi reactor, distributed and local reactivity coefficients, various fission and capture rates and fission ratios, and the prompt-neutron lifetime. Finally, with a nickel oxide reflector in place, some of the above measurements were repeated. (auth)

26844 (BAW-1249(Vol.II)) NS SAVANNAH REPLACEMENT CONTROL ROD DRIVES SAFEGUARDS REPORT. VOLUME II. DESCRIPTION OF SYSTEM MODIFICATIONS AND HAZARDS ANALYSIS. Robert E. Wascher, comp. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Oct. 1962. Contract AT(30-1)-2721. 106p.

The automatically programmed rods operate in a sequence that produces a virtually linear relationship between added reactivity and cumulative rod withdrawal. An evaluation of potential system failures showed that no credible failure prevents safety action from occurring or causes intolerable power peaking by upsetting the rod programming. The maximum potential reactivity addition rate under accident conditions is slightly higher in the replacement drive system than in the original system. Also, scram time is slower under abnormal conditions. Evaluation of the effect of these changes on the power plant accident analysis showed that the maximum potential reactivity addition rate is less than one tenth of that at which core damage or excessive primary system pressure occurs. Except for a major rupture of the primary system the core is protected from damage and the primary system from excessive pressure during any credible accident, even under abnormally slow scram conditions. A major rupture of the primary system is the maximum credible accident. Installation of the replacement control rod drives neither changes the consequence of this accident nor increases its probability of occurring. Therefore, it is concluded that the replacement control rod drives can be used on the Savannah without causing undue hazard to the public. (auth)

26845 (BAW-1277) STUDY OF CORE COOLING REQUIREMENTS DURING NS SAVANNAH REFUELING. J. H. Hicks and J. F. Bader (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). May 1963. Contract AT(30-1)-3144. 19p.

The requirements for cooling the NS Savannah reactor core during refueling were investigated. The two-part study included analysis of the system required to provide coolant flow to the reactor and to remove the decay heat generated and analysis of flow and temperature characteristics in the reactor during refueling. Since previous investigations of the system requirements were made, this study was concerned primarily with the flow and temperature analysis. (auth)

26846 (BMI-1209) CRITICAL-ASSEMBLY STUDIES ON AN INTERMEDIATE REACTOR FOR AIRCRAFT PROPULSION. Lawrence F. Marinaccio, Richard G. Jung, Francis J. Jankowski, David A. Dingee, and Joel W. Chastain (Battelle Memorial Inst., Columbus, Ohio). July 15, 1957. Contract W-7405-eng-92. 87p.

Critical-assembly experiments on a solid-fuel reactor system were performed. The prototype reactor was fueled by a UO_2-stainless steel dispersion, sodium cooled, beryllium or BeO moderated and reflected, and controlled by rotating drums, containing B_4C over a 120-deg sector, located in the radial reflector. The critical-assembly mocks up this system using beryllium blocks for moderator, uranium foils for fuel, stainless steel foils to simulate structure and cladding, aluminum to simulate sodium, and B_4C filled tubes positioned to simulate the control drums. Control of the critical assembly was achieved by moving fuel and separating the core into two sections. Experiments were performed to determine the critical mass and the complete power distribution for the two extreme positions of the control drums: poison completely in, called the 0-deg position, and poison rotated all out, called the 180-deg position. Curves of the radial and axial power distributions for these cases are presented. Detailed power-distribution measurements within simulated fuel elements are included. The critical masses were 69.00 and 50.78 kg for the 0- and 180-deg control-drum positions, respectively. From the power-distribution measurements the peak-to-average power ratios were obtained. Individual fuel elements have a maximum radial peak-to-average power ratio of 1.21 and an element ratio of 1.56. The power-distribution measurements show the axial and radial functions representing power to be separable within the accuracy of the experiments. Danger-coefficient measurements were made for several materials. The dollar unit of reactivity was calculated to be 0.0085. From the reactivity worth of the uranium-235 and the change in critical mass on rotating the critical-assembly control drums, the prototype power-reactor control was estimated to have a reactivity worth of \$8.97 or 7.62%. For the critical assembly, each of the two regulator rods was worth approximately 3 cents; one safety rod was worth from 16.8 to 21.5 cents; all safety rods were worth from \$1.68 to \$2.15; and the table gap was worth from \$3.50 to \$4.68 in reactivity for the first inch separation. (auth)

26847 (CVNA-158) CVTR IN-PILE LOOP TEST. Terminal Report. Robert N. Duncan (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Sept. 1962. For Carolinas Virginia Nuclear Power Associates, Inc., Charlotte, N. C. Contract AT(30-1)-2289. 125p.

The successful operation of an engineering proof test of a scaled-down prototype CVTR fuel element and pressure tube verified the reference design concept, fabrication methods, and choice of materials for the CVTR plant. The

in-pile loop thimble was tested in the reflector region of the Westinghouse Test Reactor under conditions similar to those expected in the CVTR plant. No failures or major problem areas attributable to the design of the CVTR core were encountered. The use of gasketed transition joints between Zircaloy and stainless steel pressure tube components for long periods of time under adverse conditions was shown to be practical. Gas leakage through the gasketed transition joints was observed during the in-pile loop test operation requiring more frequent additions of hydrogen (deuterium in the CVTR) to maintain the desired overpressure in the cooling water. No evidence of accelerated corrosion, fretting, or mechanical failure of high quality Zircaloy was found. (auth)

26848 (CVNA-162) CVTR SET POINT STUDY. J. E. Godts and E. R. Wiot (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). May 1963. For Carolinas Virginia Nuclear Power Associates, Inc., Columbia, S. C. Contract [AT(30-3)-222]. 86p.

With the aid of an analog computer, the control of the Carolinas-Virginia Tube Reactor with the modified controller was studied. The objectives were to check the controller with respect to its ability to control normal plant transients and to check the plant and determine the controller set points. This was done for both the nominal and the worst combination of plant parameters and conditions, including reactivity coefficients, rod worths, and pressurizer spray and relief valve settings. The results indicated that the modified controller is capable of handling normal plant transients and also the loss of load with turbine trip transients. The ranges of the controller set points were determined within acceptable limits and the settings for both nominal and worst conditions were within these ranges. (auth)

26849 (DLCS-3570107) REACTOR PLANT CONTAINER INTEGRITY TEST (AIR LOCK TEST). Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First Issue, Mar. 11, 1963. Second Issue, May 23, 1963. Contract AT(11-1)-292. 7p.

The integrity of the six airlocks is investigated by an air pressure test, visual inspection, and operating check. The reactor plant container airlocks will maintain integrity if the handwheel shaft packing glands are tightened to give shaft torques of 7 ft-lb. The test could therefore be supplemented by a regular maintenance check of the handwheel shaft torque and packing gland adjustment. The teflon diagonal ring packing did not effectively reduce the torque required to turn the handwheel shafts. (auth)

26850 (DLCS-3570303) REACTOR PLANT CONTAINER INTEGRITY TEST. Test Evaluation. Core 1, Seed 4. Section 3 of 4 Sections. (Duquesne Light Co., Shippingport, Penna.). First Issue, Mar. 21, 1963. Contract AT(11-1)-292. 18p.

Tests to establish a positive bolt tightness for the container hatches, reactor dome, and the container stop joints and to inspect the chamber interconnections and pipe penetrations were made. A positive bolt tightness existed on the container hatches, reactor dome, and container stop joints. The condition of the interconnections between the chambers and all pipe penetrations of the reactor plant container was satisfactory. Zero leakage from the reactor plant container to the gravity drain tank was observed. (auth)

26851 (DLCS-3570401) REACTOR PLANT CONTAINER INTEGRITY TEST. Test Evaluation. Core 1, Seed 3. (Duquesne Light Co., Shippingport, Penna.). [nd]. Contract [AT(11-1)-292]. 7p.

Test procedures were given for determining whether the modified 48-inch butterfly valves of the reactor plant container air cooling system operate satisfactorily and maintain their leak rate integrity. The modified 1C and 1D supply valves performed satisfactorily and maintained their leak rate integrity throughout the entire test period. The modified 1A and 1B exhaust valves, however, required packing replacement at the upper shaft of the 1B valve, adjustment of the 1A valve seat, and tightening of both upper shaft packing glands before the leak rate integrity was restored to the initial value. The modifications made to the new valves considerably reduced the time required to make adjustments to the neoprene valve seats. (auth)

26852 (DLCS-3990105) FEDAL SYSTEM (CHECK-OUT TEST). Core 1, Seed 3. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First Issue, Apr. 1, 1963. Contract AT(11-1)-292. 17p.

This test determines if the FEDAL System at the Shippingport Atomic Power Station is operating properly. The maintenance performed on the FEDAL System as well as the individual performances during Core 1, Seed 3 operation are discussed. (auth)

26853 (DLCS-3990243) FEDAL SYSTEM (OPERATION DURING PLANT START-UP). Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First Issue, Apr. 1, 1963. Contract AT(11-1)-292. 17p.

The FEDAL samples water at a rate of one gpm from each blanket assembly. The samples are conducted to the FEDAL monitors where they are monitored for delayed neutron emitters. During the shut down periods of the reactor, water seeps through the defects in the Zircaloy cladding of the blanket elements and waterlogs the fuel. When the reactor starts producing power, the water within the cladding flashes to steam and expands out through the defect, carrying some fission products with the steam. Iodine-137 and bromine-87 are fission products and are also delayed neutron emitters which are detectable by the FEDAL monitors. Therefore, during station start-up, a burst of activity will be seen on the FEDAL monitors if a defective element is monitored and the defect is of sufficient size, and the power production in that element is of sufficient magnitude. During Core 1, Seed 3 lifetime, a total of 74 blanket elements were monitored during station start-up. One blanket element, K-9, was the only element which gave an indication of defective cladding. (auth)

26854 (DLCS-3990306) FEDAL SYSTEM (OPERATIONAL TEST). Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First Issue, Apr. 1, 1963. Contract AT(11-1)-292. 15p.

This FEDAL test determines the activity of the delayed neutron emitters in the 113 blanket assemblies. An evaluation and discussion of the FEDAL System steady-state operation for Core 1 from original start-up through Seed 3 are presented. The six Seed 3 performances of DLCS 39903 are emphasized in the discussion and evaluated in conjunction with the various factors which affect the magnitude of the delayed neutron activity. (auth)

26855 (EUR-85.e) ORGEL—A EUROPEAN POWER REACTOR DESIGN. J. C. Leny, S. Orlowski, J. C. Charrault, and F. Lafontaine (European Atomic Energy Community). 1962. 35p.

The general features of the ORGEL Power Plant as well as the various parts of the research and development program associated with it are described. The

ORGEL (ORGanique-Eau lourde) Program was started by Euratom at the beginning of 1960. Part of the researches are performed by the services of the J.R.C. of Ispra, while the project will have the use of installations at BR-2, Mol, Belgium, in H.F.R. Petten, Holland and in Grenoble, France. The main aspects of this plant are discussed, such as the fuel element, the organic coolant, the reactor structure, the fuel handling system, and the conventional part. The method used to optimize these various components on the economical view point is indicated. The results of these optimization studies show how the economy of the reactor is influenced by such parameters as flux flattening ratio, reactor height, moderator to fuel volume ratio, radial reflector thickness, organic coolant flow and velocity, and rod clearance in the fuel cluster. Finally a table gives the set of values for the power plant characteristics. (auth)

26856 (GC(V)/INF/38) NUCLEAR POWER COSTS. (International Atomic Energy Agency, Vienna). Sept. 13, 1961. 41p.

Data on the costs of nuclear power are presented. Capital cost, fueling cost, other operating costs, considerations of financing, and future trends are discussed. An attempt was made to indicate how the cost data can be evaluated to suit specific local conditions and accounting practices. (M.C.G.)

26857 (GEAP-3962) SIMPLIFIED POWER CONVERSION UNIT STUDY. P. M. Clark, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 1962. Contract AT(04-3)-189. 223p.

Results of a feasibility study on a simplified power conversion unit primarily for use with nuclear steam power plants for military applications are reported. Power levels considered are 500, 1250, and 2500 kw(e). Included are the following: design information, design curves, drawings, illustrations, control study information, cost information, and a description of the development programs leading to the realization of a capsule power conversion unit. (auth)

26858 (GEAP-4219) HIGH POWER DENSITY DEVELOPMENT PROJECT. Twelfth Quarterly Progress Report, January–March 1963. L. K. Holland, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 15, 1963. Contract AT(04-3)-361. 59p.

The number of original fuel bundles under irradiation in the VBWR core was reduced from 24 to 16 as a result of fuel rod service failures. Installation of pool facilities at Consumers Big Rock Point Reactor was completed. Thirty initial core fuel bundles were gamma scanned using the pool facilities. The fabrication of special assembly 11S was completed. The fuel rods for 11S consisted of four swaged pellet and twelve swaged powder fuel rods clad in 0.010-inch thick 304-L stainless steel. Spacer and assembly hardware damage to assemblies 1S and 4S during in-core handling required fabrication of new assembly structure components. Fuel assembly 2S (swaged powder fuel) was examined after in-core sipping tests indicated possible fuel rod failures. Examination revealed one fuel rod to have a longitudinal clad crack 7 inches long. Four instrumented assemblies for Big Rock Point were calibrated for flow in the heat transfer loop under single and two-phase flow conditions. Bearing characteristics and performance were evaluated as part of the simulated reactor operating conditions of flow, temperature, and pressure. Stability test equipment was assembled and tested preparatory to shipping to Big Rock Point. To expand on empirical methods previously used to calculate control blade worth, three analytical methods were evaluated. Comparison between power distribution at Big Rock Point, as determined by gamma scan and the FLARE analytical method, was made, and good agreement was shown. FLARE was shown to underestimate, somewhat, the axial peaking factor, and tended to increase the power in the core bottom relative to the core top. A basic program system was checked out and run on the 312 computer at Big Rock Point. This includes the majority of the calculational packages, a basic executive control routine, and the necessary utility packages to allow the system to operate. (auth)

26859 (GNEC-174) FABRICATION PROCESS DEVELOPMENT ON BONUS-TYPE COLLAPSED-CLAD FUEL ELEMENTS. Interim Report. (General Nuclear Engineering Corp., Dunedin, Fla. and Combustion Engineering, Inc., Windsor, Conn.). May 17, 1961. Contract AT(11-1)-795. 42p.

A manufacturing process was developed for collapsing stainless-steel clad on UO_2 fuel pellets during fabrication of the superheater fuel elements for the BONUS reactor. Studies of various collapsing processes led to the selection of a system of stretch-forming. The stretch-forming technique was successfully applied to the operation of collapsing the stainless-steel cladding on pelletized UO_2 fuel and end spacers that have a total stack length of nearly 60 inches. (auth)

26860 (HPR-29) HBWR QUARTERLY PROGRESS REPORT, OCTOBER TO DECEMBER 1962. (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). Apr. 1962. 135p.

The reactor was successfully brought up to power of 14 Mw for the first time with the second fuel charge. The first experiments at power were concerned with the testing of the first instrumented fuel assembly. During a shut-down the fuel handling and storage facilities were brought up to standards. The effect of gamma-heating in cadmium was investigated with a particular view on the cadmium absorber for the oscillator which is to be used for the transfer function measurements. The effect of the reactor to changes in tertiary steam output was studied as it was found that a sudden increase in steam output could initiate flash boiling in the moderator. At the same time the effect of the reactor to a negative reactivity step at power was investigated, since large negative reactivity changes could also initiate moderator boiling. An experiment to determine the xenon transients was also performed. Two operating experiments, testing of an automatic power control system and testing of shielding types for the fission product monitoring system were made. (N.W.R.)

26861 (KR-35(Vol.III)) ADVANCED COURSE ON THE DYNAMIC BEHAVIOUR OF BOILING WATER REACTORS ORGANIZED BY THE NETHERLANDS'–NORWEGIAN REACTOR SCHOOL AT INSTITUTT FOR ATOMENERGI, KJELLER, NORWAY 20th AUGUST–31st AUGUST 1962. VOLUME III. (Netherlands'–Norwegian Reactor School. Advanced Study Inst., Kjeller, Norway). 1962. 247p.

Nine papers are presented on the dynamic behavior of boiling water reactors. Information included consists of basic theory of noise analysis, application of computers to a boiling water reactor, dynamic characteristics of nonlinear systems, burnout mechanisms for flow of boiling water is vertical channels, stability testing of the reactors, acoustical oscillation in steam systems, and stability of nonlinear systems. (N.W.R.)

26862 (MND-MD-2560-7) PM RESEARCH AND DEVELOPMENT PROGRAM 7th QUARTERLY PROGRESS

REPORT, OCTOBER 1, 1962 TO DECEMBER 31, 1962. (Martin-Marietta Corp. Aerospace Div., Baltimore). Contract AT(30-1)-2706. 153p.

Accomplishments during the seventh project quarter of the PM R&D Program are described in terms of: core design development; fuel element and core component development; irradiation testing, critical experiments and zero-power testing; and reactor flow tests. Core Design Development. Final design of Core 2 was continued. All core and refueling tool drawings were completed except for the lumped poison drawing. Based on irradiation test data, B_4C – Zircaloy-2 poison elements were specified in place of $B_4C-Al_2O_3$; drawing and product specification changes were initiated. Core 2 nuclear design analysis is nearly complete; possible nuclear effects of the change from alumina to Zircaloy-2 poison element matrix are being evaluated. Core 2 thermal and hydraulic design analysis was completed. Core 3 parametric study continued. Preliminary analysis indicates that core lifetimes range from 80 to 120 Mw-yr for fuel element loadings of interest. Fuel Element and Core Component Development. Evaluation of specimens from first isostatic pressing run was completed. Two of nine tubes and six of 14 coupons were successfully densified. Remaining specimens exhibited partial or no densification. Irradiation Testing. One lumped poison pellet irradiation capsule was discharged from the reactor and the contained pellets were evaluated. Zircaloy-2 pellets were far superior in performance to alumina pellets. Design of Core 3 irradiation specimen holder was completed. Nuclear and thermal-hydraulic analysis of the experiment continued. Flux suppressors are required to limit axis power peaking between heavily loaded tubular specimens. Preparation of stainless steel coated, spherical UO_2 continued. Incomplete reduction of the oxide coatings resulted from impurities in the reducing atmosphere. Twenty-three tubular and 30 flat plate specimens were fabricated and isostatically pressed. The Fuel Processing Facility was completed and checked out, and the feasibility report for its operation was approved by AEC. Critical Experiments and Zero-Power Testing. Reduction of experimental data from Core 2 mockup studies was completed. Core reactivity is $10.62 \pm 0.13\%$ $\Delta k/k$. Rod bank worth, shutdown margin, and power distribution are reported. Peak-to-average power ratio is 3.08. Temperature coefficient of reactivity at 20°C is -0.83×10^{-4} $\Delta\rho$/°C. Analysis of the lumped poison element experiments was completed. Reactor Flow Tests. Core 2 bundle flow test experimental program was completed. The test data were reduced and analyzed. A flow split, ratio of inside flow to total tube flow of 0.495 for average Core 2 element is predicted. Based on this result, resizing of grid plate orifices is not required. (auth)

26863 (MND-MD-2560-8) PM RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report No. 8, January 1, 1963 to March 31, 1963. (Martin-Marietta Corp. Aerospace Div., Baltimore). Contract AT(30-1)-2706. 113p.

The final design of PM-1 Core 2 was completed; final drawing and specifications were released. Nuclear and mechanical studies in support of the final design were completed. The parametric lifetime study of PM Core 3 was completed. Studies of the Core 3 control system were initiated. Material and assembly process specifications for the Core 2 lumped poison element were prepared and issued. Evaluation of all lumped poison irradiation specimens was completed. High B-10 burnup specimens confirmed the suitability of B_4C-Zircaloy 2 poison pellets for Core 2 service. Fabrication of prototype holders for the Core 3 irradiation test program was completed. Flow, vibration, and flow visualization tests were performed using the prototype holders. Nuclear analysis of the Core 3 irradiation experiment was completed except for depletion studies. Analysis of the lower power irradiation tests began. Thermal and hydraulic analysis of the Core 3 irradiation experiment was completed. Nominal coolant flow rate was increased to 46.5 gpm. Nominal maximum fuel temperature of 785°F is predicted. Spheroidizing and coating of all natural UO_2 required for fabrication process development was completed. Processing of enriched material was initiated. Reference fabrication processes for Core 3-type tubular and coupon irradiation specimens were established. Fabrication of Core 2-type tubular irradiation specimens has progressed through the isostatic pressing step. (auth)

26864 (NP-12869) PRELIMINARY HAZARDS SUMMARY REPORT FOR THE CONSOLIDATED EDISON INDIAN POINT REACTOR, CORE B. (Consolidated Edison Co. of New York, Inc. and Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). [nd.] 83p.

The power capability of Core B is the same as for Core A, 585 Mw(t). The core consists of slightly enriched uranium dioxide pellets clad in stainless steel tubes which form a lattice, roughly cylindrical in shape, with an overall active height of 101.5 in. and an equivalent diameter of 67.15 in. Demineralized light water flows upward through the lattice acting as both moderator and coolant. The core contains 120 fuel assemblies, divided into three concentric regions. Twenty-one control rods are provided for reactivity control. Additional reactivity control is provided by the use of soluble poison. Considering the consequences of a full range of credible accidents, results of the Core B analyses indicate that there is no significant hazard to the general public, plant personnel, or the facility itself as a result of operating the second core within the limits proposed. (N.W.R.)

26865 (NP-12873) UTILIZATION OF NUCLEAR POWER PLANTS IN UNDERGROUND INSTALLATIONS. (Office of the Chief of Engineers, Washington, D. C.). Apr. 15, 1963. 42p.

Information is provided on nuclear power for underground installations that might be required to operate in a completely closed and isolated situation over a period of days or weeks. Topics discussed include: sources of power, alternative power generation equipment, existing studies, advantages and disadvantages, requirements of supported facility, logistical considerations, utility requirements of facility, character of connected power loads, site characteristics, heat sinks, projected facility life, plants currently available, economic considerations, scheduling consideration, physical characteristics, and requirements unique to nuclear power plants. (M.C.G.)

26866 (NYO-10280) THE EFFECT OF AEC SITE SELECTION PRACTICE ON POWER TRANSMISSION COSTS AND THE POTENTIAL NUCLEAR MARKET. L. Geller, J. F. Hogerton, F. J. Leerburger, and S. M. Stoller (Stoller (S. M.) Associates, New York). Mar. 26, 1963. Contract AT(30-1)-2987. 55p.

Thirty-five electric utilities in high-cost fuel areas were asked to look at their generating stations now in operation, or to be placed in operation within the decade 1958–1967, and to determine whether they meet certain nuclear siting requirements. For those stations not

meeting these requirements, they were asked to select alternate station sites and to estimate the differential power transmission costs arising therefrom. Using the information so developed, as well as company projected unit additions for the years 1967–1969 and a set of assumed generating costs it is concluded that: the nuclear site requirements specified are met by very few existing or planned station sites; alternate site differential transmission costs vary quite widely; and the short-term market for nuclear power will probably be somewhat reduced by nuclear site considerations; the long-term market for nuclear power could be seriously restricted if the site requirements used in the survey had to be met. (auth)

26867 (ORNL-TM-557) RESTRAINED THERMAL BOWING OF BEAMS ACCOMPANIED BY CREEP—WITH APPLICATION TO THE EXPERIMENTAL GAS-COOLED REACTOR FUEL ELEMENTS. J. M. Corum and W. A. Shaw (Oak Ridge National Lab., Tenn.). [June 10, 1963]. Contract W-7405-eng-26. 54p.

An analytical procedure is formulated for predicting the lateral deformation of a long slender beam when the material is subjected to creep conditions. The beam has simply-supported ends, is restrained at the midpoint, and is loaded by a temperature differential wherein the temperature is a linear function of the thickness. The creep strains are predicted by employing a constant-stress creep law consisting of a secondary or steady creep term only. Both the restraining force at the midpoint and the deflection profiles for the beam may be obtained as functions of time using the analytical method presented. The analysis is applied to the Experimental Gas-Cooled Reactor fuel elements for several mean temperatures and temperature differentials, and, in every case, the limiting maximum deflection of a fuel rod is e/5.13, where e is the maximum deflection without a restraint at the midpoint. This is significant because, although an infinite time is required for a rod to reach its maximum deflection, this deflection will be closely approached during the projected fuel element residence time in the higher temperature regions of the reactor. (auth)

26868 (PRWRA-GNEC-7) BOILING NUCLEAR SUPERHEATER (BONUS) POWER STATION. RADIATION PROTECTION STANDARDS. (Puerto Rico Water Resources Authority, San Juan and General Nuclear Engineering Corp., Dunedin, Fla.). Dec. 1, 1961. Contract AT(40-1)-2674. 60p.

Radiation protection standards developed for use at the Boiling Nuclear Superheater Power Plant are presented. Radiation and contamination limits for personnel and equipment are listed. Operating regulations, routine operations, emergency procedures and facilities, and detection instruments and equipment are described. A summary of permissible radiation exposure limits is also presented. (C.E.S.)

26869 (TID-11734) FINAL HAZARDS REPORT FOR THE RCPA ELK RIVER REACTOR AT ELK RIVER, MINNESOTA. (Allis-Chalmers Mfg. Co. Nuclear Power Dept., Washington, D. C.). July 8, 1960. Contract AT (11-1)-654. 374p.

An analysis of the maximum credible accident for the Elk River Power Reactor is presented. The power reactor is described along with operation procedures. Evacuation procedures are included. (N.W.R.)

26870 (WAPD-MRP-103) PRESSURIZED WATER REACTOR (PWR) PROJECT TECHNICAL PROGRESS REPORT FOR THE PERIOD FEBRUARY 24, 1963 TO APRIL 23, 1963. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Contract AT-11-1-GEN-14. 126p.

Progress on the Shippingport Pressurized Water Reactor is reported. Topics covered include: plant modification, plant decontamination, reactor engineering, metallurgy of core materials, core operations, and reactor physics. (N.W.R.)

26871 (WCAP-4187) CVTR PROJECT. CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. MONTHLY PROGRESS REPORT, MAY 1963. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Contract AT(30-1)-2289. 7p.

Research and development progress was reported on the Carolinas-Virginia Tube Reactor. The topics covered include primary coolant system pressure drops, reactor transients, plant nuclear evaluation, ultrasonic inspection of pressure tubes, and metallurgical examination of reactor components. (C.E.S.)

26872 (WCAP-6054) YANKEE CORE EVALUATION PROGRAM. Quarterly Progress Report for the Period Ending March 31, 1963. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Apr. 26, 1963. Contract AT(30-1)-3017. 132p.

The initiation of shipping and examination activities on irradiated fuel elements, and the completion of design and testing efforts on all related "hardware" items are described. Details on the planning and preparation activities which preceded to initiation of core examination work are provided. Efforts relating to the examination of Yankee fuel assemblies and control rods, including the arrangements and equipment for transporting the core components to the post-irradiation facility, the design and procurement of special equipment required for the examination work, and performance of the actual data-gathering and related activities are discussed. Transportation of three Yankee irradiated fuel assemblies and one control rod absorber from the Yankee Site to the Westinghouse Post-Irradiation Facility is described. Initial efforts on the underwater examination and disassembly operations on irradiated fuel elements were completed. Results of the gamma scans made on three irradiated Yankee fuel assemblies are presented. The evaluation of the data and to its significance with regards to the performance of Yankee Core I is described. Procedures to be followed in the core examination aspects of the project are defined. Initial evaluations were made of the data obtained. Calculations of predicted burnups were made for samples to be analyzed and evaluated under this project. Initial evaluations were carried out on the effect of the spatial variation of neutron spectrum in Yankee Core I. Gamma scanning measurements performed on three irradiated Yankee fuel assemblies were evaluated. The revision of nuclear design methods, taking into account information obtained in tests, is described. The initial efforts made on the adaptation of fuel depletion computer programs to the needs of this project are discussed. Studies made on methods of evaluating resonance capture rates are described. Exploratory calculations for multigroup neutron spectrum analysis are given. Methods for calculating thermal utilization were evaluated. (auth)

26873 COMBINED ATOMIC-ELECTRIC POWER PLANTS AND THEIR THERMAL EFFICIENCY. C. Haiduc. Acad. Rep. Populare Romine, Studii Cercetari Energet. Ser. B, 12: 449-67(1962). (In Rumanian)

A new type of atomic-electric power plant is studied.

Relations are given for determining the gross, net, and electric output of combined atomic-electric power plants, as well as for increasing the electric energy of the nuclear stage when combining atomic-electric and thermoelectric power plants. The superiority of the thermal efficiency of this new type of plant, in comparison with atomic-electric plants with saturated steam or with overheated steam, based on nuclear or on classical fuel, is proved by examples. (auth)

26874 THE NUMERICAL CALCULATION OF THE TEMPERATURE FIELD IN THE COOLING-GAS FLOW TO THE EXIT OF THE FISSION ZONE IN A PEBBLE-BED REACTOR. R. Pruschek (Technische Hochschule, Stuttgart). Atomkernenergie, 8: 161-5(May 1963). (In German)

The temperature distribution in the coolant flow through the core of a gas-cooled pebble bed reactor was investigated. The following model was introduced for numerical solution: the core is subdivided by coaxial hollow cylinders, i.e., in coolant channels with annular cross sections. According to the nonuniform heat production within the core (according to the flux distribution) the coolant tends to expand more strongly in the inner coolant channels than in the outer ones. The walls of the assumed cylinders may be displaced in radial direction in such a way that constant pressure within any cross section perpendicular to the axis of the core is established. By this measure a picture of the coolant flow through the pebble bed core is obtained. The effective heat conductivity of the streaming coolant caused by turbulent eddies and mixing is neglected. Former publications on this subject are considered. (auth)

26875 A METHOD FOR OPTIMIZING GAS-COOLED REACTOR PARAMETERS. M. Novaković. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 1-16(Jan. 1963). (In English)

A method is presented for optimizing the thermal parameters of a heterogenous gas-cooled nuclear reactor. The efficiency of certain types of fuel elements and the optimal parameters of a reactor (based on maximum specific power) can be determined by a system of equalities and inequalities which gives the dependence between reactor parameters, the temperature limitations of materials, and the relative pumping power. It is also shown how the method can be applied for optimization based on an arbitrary criterion. (auth)

26876 NUCLEAR POWERED SHIP. Franco Spinelli (Università, Naples). Comit. Nazl. Energia Nucl., Notiziario, 9: 43-59(Apr. 1963). (In Italian)

After a brief survey of the nuclear-powered merchant ships now in operation or being planned, an economic comparison is made between nuclear-powered and conventional-powered ships. The safety of nuclear ships is also discussed. (J.S.R.)

26877 REACTORS FOR THE PRODUCTION OF ELECTRICITY. M. Pascal (CEA, Paris) and J. P. Roux. Energie Nucl., 4: 182-8(May-June 1962). (In French)

The comparative descriptions of the natural-uranium, graphite, and carbon-dioxide reactors G1 and G2 at Marcoule and EDF1, EDF2, and EDF3 at Chinon point out the stages of evolution which tend to depict the model of French nuclear power stations of the future. The particularities which characterize these power reactors are discussed, and an account of the tests carried out on scale models and prototypes, with a view of developing the reactors and the associated equipment, is given. (auth)

26878 PROBLEMS OF THE INDUSTRY WHEN CONSTRUCTING NUCLEAR POWER STATIONS, ILLUSTRATED BY THE EXPERIMENTAL NUCLEAR POWER STATION KAHL. H. H. Horlacher (Abteilung Kernenergieanlagen der AEG, Frankfurt am Main). Kerntechnik, 5: 167-71(Apr. 1963). (In German)

It is demonstrated by a selected number of examples taken from the construction of the Experimental Nuclear Power Station (Kahl) which special problems in comparison with those in conventional power stations arise for the industry participating in the erection of a nuclear power station. The manufacturing procedures and special measures necessary for complying with the requirements to be made on the individual plant component are described. (auth)

26879 A METHOD FOR DETERMINATION OF SPATIAL STABILITY. Stig Lundquist and Peter Weissglas (Swedish State Power Board, Vällingby, Sweden). Nucl. Sci. Eng., 15: 474-5(Apr. 1963).

Spatial variations constitute one of the major difficulties in power reactor kinetics. A method is demonstrated in which use is made of Liapunov's second method combined with a variational principle to give a sufficient criterion. For this method it is obvious that nonlinear terms can be neglected, whereas methods involving series expansions require proof of uniform convergence. Practical application by hand calculation to three-dimensional inhomogeneous reactor models is possible. (auth)

26880 NEUTRON TEMPERATURES IN A CANDU-TYPE POWER REACTOR. B. G. Chidley, R. B. Turner, and C. B. Bigham (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 16: 39-67(May 1963).

Relative reaction rates were measured in the fuel and moderator of a CANDU-type lattice cell and analyzed to obtain the spectrum parameters, i.e., effective neutron temperature T and epithermal index $r\sqrt{T/T_0}$. Measurements were made with the coolant channels containing the normal heavy water and also light water and mixtures of light and heavy water at temperatures up to 280°C. An empirical formula was derived for the effective neutron temperature in the fuel of operating power reactors with similar fuel geometries. (auth)

26881 THE SLOWING-DOWN SPECTRUM IN A CANDU-TYPE REACTOR. C. B. Bigham, B. G. Chidley, and R. B. Turner (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 16: 68-84(May 1963).

The slowing-down spectrum in a CANDU-type reactor cell was studied using resonance activation techniques. The measurements covered the energy range 1.46 to 367 ev. The effects of replacing the heavy water coolant with mixtures of light and heavy water and light water were studied. Measurements were also made in a channel without fuel clusters. The spectra observed in the normal cell were approximately 1/E throughout the cell except for depressions caused by prominent U^{238} resonances. With no fuel in the cell, large departures from 1/E were observed. (auth)

26882 METHOD FOR CONTROLLING THE COOLING OF A NUCLEAR POWER REACTOR. W. Robert Wooton and R. Valentine Moore (to Babcock and Wilcox Ltd. and United Kingdom Atomic Energy Authority). German Patent DAS 1,145,635. Mar. 21, 1963. Filed July 7, 1956.

The method described relates to nuclear reactor-heated boiler systems comprising means for circulating a heat transferring fluid through the reactor and then through the boiler in a closed circuit. It is desirable in such a system to operate the reactor in a manner so that

the temperatures of the fluid on entering and leaving the reactor remain constant even when the load changes. According to the method, the outlet temperature is maintained at a predetermined figure as the load changes by controlling the mass flow of the heat transferring fluid, and the temperature at the inlet to the reactor is maintained at a predetermined figure by controlling the pressure in the boiler according to load. (Gmelin Inst.)

26883 PRESSURE SUPPRESSION CONTAINMENT FOR NUCLEAR POWER PLANT. Albert Ziegler and Gerd Petersen (to Siemens-Schuckertwerke AG). German Patent DAS 1,146,598. Apr. 4, 1963. Filed June 14, 1961.

The pressure suppression containment described is for the condensation of eventually escaping water vapor by a spray device. The reactor building consists of an outer pressure container and an inner building made of concrete which houses the nuclear reactor. At the highest point of the pressure container below its ceiling, there is a water reservoir which is connected via piping with the space between the pressure container and the concrete building. The spray devices are attached to the end of the piping which are distributed below and above the concrete building. The air space above the water level of the reservoir communicates via a vent pipe with the space surrounding the nuclear reactor. The separated spaces within the pressure container are mutually connected by pipes which are normally closed by rupture diaphragms. (Gmelin Inst.)

26884 DEVICE FOR COMPENSATING SUDDEN CHANGES IN LOAD OF STEAM POWER PLANTS FEATURING A PRIMARY AND A SECONDARY CIRCUIT, e.g. OF NUCLEAR POWER PLANTS. Grady L. Harthield and Harry A. van Wassen (to Westinghouse Electric Corp.). German Patent DAS 1,147,241. Apr. 18, 1963. Priority date Jan. 24, 1958, United States.

The device described is for compensating a sudden relief of load in nuclear power plants featuring a primary and a least secondary circuit. In order to prevent inadmissible pressure rises within the primary system, such as those stemming from sudden reliefs of load in a secondary or tertiary circuit, safety relief valves are provided. But because of radioactivities which can escape, the opening of these safety valves should be restricted to emergency cases only. This can be achieved by providing relief valves in the secondary circuit through which the working medium might be expanded according to the momentary load in such a way that the action of a sudden relief of load on the primary circuit is retarded and the velocity of pressure change does not release the safety valves. (Gmelin Inst.)

26885 NUCLEAR POWER PLANT WITH TWO SEPARATE PRIMARY CIRCUITS. Paul Profos (to Gebruder Sulzer AG). German Patent DAS 1,147,330. Apr. 18, 1963. Priority date Aug. 29, 1959, Switzerland.

The described nuclear power plant features a nuclear reactor with two separately operated closed primary circuits for extracting the heat generated in the core and transferring it via heat exchangers to a secondary circuit with a turbine system. The two primary circuits contain different coolant media and have two different working temperatures. The primary coolant medium in the circuit with the lower outlet temperature gives up its heat in an evaporator where steam is raised in the secondary circuit, and the coolant medium flowing through the other primary circuit is for superheating the steam raised by said first primary coolant. For gaining higher efficiency and for lowering the temperature in the core, the coolant medium with the higher outlet temperature, after leaving the superheater heat exchanger, passes through an auxiliary heat exchanger in which additional steam is raised in the secondary circuit. (Gmelin Inst.)

26886 NUCLEAR POWER PLANT WITH A HETEROGENEOUS REACTOR PROVIDED WITH PRESSURE TUBES. Jakob Kaegi (to Gebruder Sulzer AG). German Patent DAS 1,147,331. Apr. 18, 1963. Priority date May 17, 1960, Switzerland.

A nuclear power plant is described with a heterogeneous nuclear reactor and a core which is provided with pressure tubes through which steam as working medium is made to flow. The steam is superheated as it passes through the reactor core. One part of the superheated steam flows to a steam generator to give up some of its heat while the rest of the steam is recirculated through the core to be further superheated and afterwards fed into a power plant, e.g., a turbine. The pressure tubes within the core are divided into two groups of which the first one is located in the central zone and is for superheating the steam entering from the steam generator, and the second one is located in the outer parts of the core and is for further superheating that part of the steam which after passing the central zone is recirculated through the core and which is fed into the turbine. (Gmelin Inst.)

26887 TRANSPORTABLE NUCLEAR REACTOR POWER PLANT. Tibor F. Nagey, Jack A. Hunter, and William A. Maxwell (to Martin-Marietta Corp.). U. S. Patent 3,086,933. Apr. 23, 1963. Filed Feb. 4, 1960.

The design of a heterogeneous, pressurized, light-water-moderated and -cooled reactor power plant is patented and described. The power plant is relatively small and readily transportable to the site of operation and is of inherently simple design, which is safe and reliable in operation. To reduce weight, no thermal shielding is provided within the pressure vessel. Shielding is accomplished by the pressure shell and the water in which the reactor is submerged. The fuel elements are of tubular geometry with improved structural strength and rigidity, so that no supporting structure is needed within the nuclear core. The design and performance of the reactor are described in detail. (M.P.G.)

26888 NUCLEAR FISSION REACTION PROCESS. Bernard L. A. van der Schee (to Stichting Reactor Centrum Nederlands). U. S. Patent 3,092,562. June 4, 1963. Priority date June 25, 1955, Netherlands.

A homogeneous suspension-type reactor is designed in which the settling out of the suspension particles is minimized. In this reactor, the suspension is passed through the reactor vessel in upward flow rather than downward flow. Thus, convection currents and trapped gas bubbles are prevented, and the inventory of fissile material in the circuit outside the reactor is smaller than in the case of downward flow. (D.L.C.)

Production Reactors

26889 (TID-18744) TEXTURE GRADIENTS IN MARK VB ELEMENTS. B. G. LeFevre and E. F. Sturcken (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [June 1963]. Contract AT(07-2)-1. 16p.

Some data from experimental x-ray-diffraction techniques used at SRL for measuring texture gradients in thick-wall beta-treated uranium fuel tubes are presented. The data show the texture variation across the wall of a Mark VB oversize outer element, a hot-press-bonded

Mark VB outer element, and an unclad Mark VB outer element. The experimental techniques are reviewed. The relation between dimensional stability and texture is given. (N.W.R.)

26890 (AEC-tr-5828) ENGINEERING OF CAISSONS. J. Bellier and M. Tourasse. Translated for Oak Ridge National Lab., Tenn. from Bull. Inform. Sci. Tech. (Paris), No. 20, 56-8(1958). 32p.

The caissons of the G2 and G3 reactors are identical in all of their engineering aspects. They consist of a horizontal cylinder of 14 m ID and 18 m length, closed at each end by a hemispherical cupola, which is concave towards the outside. The wall thickness is 3 m. A concrete superstructure in the lower part forms two girders by means of which the caisson rests on its foundation. Role of the prestress, advantages of prestressing, general arrangements, construction of caissons, structure of cables, support of binding on concrete, manufacture of cables, placement of cables, tension of prestressed cables, protection of cables, temporary openings for interior installations, measurements in and on the caissons, role of floors, foundation, monitoring for fatigue and verticality, and calculations are discussed. (M.C.G.)

26891 RESEARCH AND DEVELOPMENT IN THE POWER REACTOR FIELD. M. Silvestri (CISE, Milan). Energia Nucl. (Milan), 9: 640-3(Nov. 1962). (In English)

Research and development are two stages of a single process which follow each other in time. The difficulty lies in distributing them and in deciding when to stop research and to start development. As generally the supreme decision of going ahead is in the hands of men of reduced competence in the specific item, the expensive research and development machine is often started without sufficiently evaluating the real difficulties of the venture, and possibly it ends in a blind alley. A close cooperation and a common responsibility between scientists and technologists, a specific competence of men at the top, and a better weighed graduality of efforts seem to be needed for satisfactory achievements without waste of efforts and money. (auth)

Research Reactors

Refer also to abstracts 24764, 26009, 26055, 26056, 26057, 26058, 26070, 26076, 26091, 26092, 26133, and 26183.

26892 (ANL-6707) BORAX V EXPONENTIAL EXPERIMENT. F. S. Kirn and J. I. Hagen (Argonne National Lab., Idaho Falls, Idaho). Apr. 1963. Contract W-31-109-eng-38. 25p.

The cadmium ratio was measured in an exponential mockup of Borax V as a function of the void fraction. The extent of voids, simulated by lengths of closed polyethylene tubes, ranged from 0 to 40%. The corresponding cadmium ratios ranged from 6.1 to 4.6. The exponential was also used to determine the radial flux pattern across a Borax-type fuel assembly and the fine flux detail in and around fuel rods. For a normal loading the maximum-to-average power generation across an assembly was 1.24. (auth)

26893 (GA-4130) TEMPERATURE COEFFICIENT CALCULATIONS FOR THE EXPERIMENTAL BERYLLIUM OXIDE REACTOR. A. J. Goodjohn and A. D. McWhirter (General Atomic Div. General Dynamics Corp., San Diego, Calif.). May 1, 1963. Contract AT (04-3)-187. 16p.

As a result of these calculations, it is concluded that the EBOR temperature coefficient is negative at all temperatures below the melting point of the Hastelloy. The accuracy of the results remains to be proved by direct measurement, but it is felt that the calculated values are not misleading. The U^{238} effect, which is the most substantial, is calculated by proven methods. The method for calculating the U^{235} effect is not so time-tested, but sufficient work is done with it to provide some measure of confidence. The elaboration with which the calculations are performed, and the consistency of the results obtained, indicate that a certain measure of confidence can be placed in the results of the delayed effects. Short of performing a temperature coefficient experiment with a detailed nuclear mockup, it is believed that these results represent the best that can be obtained at the present time with the methods available. (auth)

26894 (NP-12892) FINAL HAZARDS SUMMARY, ZERO POWER REACTOR-II. Patrick M. Finnegan and David E. Hinkley (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). May 1963. 136p.

A hazards analysis is given of the uranyl fluoride-water solution type zero power reactor (ZPR-II) which is used for analysis of heterogeneous reactors. Information is presented on site and facility characteristics, reactor design and operating characteristics, nucleonic characteristics, proposed experimental programs, reactor facility operating standards and procedures, and a summary of the safeguards and hazards considerations. (N.W.R.)

26895 (ORNL-3359) PRELIMINARY SOLUTION CRITICAL EXPERIMENTS FOR THE HIGH-FLUX ISOTOPE REACTOR. J. K. Fox, L. W. Gilley, and D. W. Magnuson (Oak Ridge National Lab., Tenn.). June 12, 1963. Contract W-7405-eng-26. 85p.

The design of the High-Flux Isotope Reactor (HFIR) was supported by a series of preliminary experiments performed at the Oak Ridge Critical Experiments Facility in 1960. The experiments yielded results describing directly some of the expected performance characteristics of the reactor and strengthened the calculational methods used in its design. The critical assembly, like the reactor, was of a flux-trap type in which a central 6-in.-dia column of H_2O was surrounded by an annulus of fissile material and, in turn, by an annular neutron reflector. The fuel region contained a solution of enriched uranyl nitrate in a mixture of H_2O and D_2O and the reflector was a composite of two annuli, the inner one of D_2O surrounded by one of H_2O. In most experiments the ends of the assembly were reflected by H_2O. Important results evaluate the absolute thermal-neutron flux to be expected in the design reactor and describe the flux distributions within this type of assembly. It was also observed that the cadmium ratio along the axis of the assembly was about 100, showing that a highly thermal-neutron flux was truly developed in the trap. It was shown that reduction of the hydrogen density in the central water column to about 60% of its normal value increased the reactivity about 6% and that further hydrogen density reduction decreased the reactivity as the effect of the loss of neutron moderation dominated the effect of the increased coupling across the central column. These considerations are of importance to the safety of the reactor. Additional experiments gave values of the usual critical dimensions and explored the effects on both the dimensions and the flux distributions

of changing the concentration of the uranyl nitrate solution, of changing the composition of the solvent, and of adding neutron-absorbing materials to the D_2O reflector. These changes were made to alter the neutron properties of the fuel solution over a range including those expected in the reactor itself. (auth)

26896 (PAN-104/IX) CONTROL AND SAFETY SYSTEM FOR CRITICAL EXPERIMENT ON THE WATER-GRAPHITE CRITICAL ASSEMBLY OF THE 2nd POLISH REACTOR. Wacław Dabek, Zdzisław Domosławski, Andrezej Janikowski, and Bronisław Szczechla (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 21p.

The general principle of the system, block diagrams of the electronic measurement channels, and descriptions of interlocks and control circuits of the safety rods and moveable fuel elements are given. The block diagram of the radiation protection system and the detector localization are described. Some remarks are made about the fitting of the system and checking its work before the starting of the critical experiment. (auth)

26897 (PAN-109/XI) PRIVODY REGULIRUYUSHCHIKH I AVARIINYKN STERZHNEI KRITICHESKOI SBORKI MARYLA. (Control and Safety Rod Drives for the Critical Assembly MARYLA). Adam Kurkevich and Ezhi Dlugolentski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 8p.

Design principle and prototype solutions of the tube drives of the control and safety rods for the critical assembly MARYLA are discussed. In the construction presented the driving cables and leading blocks can be avoided and the control and safety rod channels can be moved easily in the reactor core together with their drives. Thus a high flexibility of the core configuration is achieved. (auth)

26898 (PAN-412/IX) RADIATION PROTECTION SYSTEM FOR THE CRITICAL ASSEMBLY OF THE 2nd POLISH REACTOR. Wacław Dabek, Andrzej Janikowski, and Bronisław Szczechla (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 13p.

The characteristics of the radiation protection system, detector position in the critical assembly building, and the mean dose rate exceeding system are given. The gamma radiation level measuring line, consisting of the KPDG-1/10 type ionization chamber, logarithmic amplifier, radiation level overpass, and failure signalizer, is described. (auth)

26899 (PAN-415/XII) TOKOVOI, LOGARIFMICHESKII KANAL "S" SISTEMY UPRAVLENIYA I ZASHCHITY REAKTORA NULEVOI MOSHCHNOSTI ANNA. (The Log-Current Channel "C" of the ANNA Zero Power Reactor Control System). Vlodzimezh Kulishkevich (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 13p.

The instrumentation and safety channel "C" provides a continuous control of the reactor power and the power change rate over the entire operating range of the zero power reactor, i.e., from 10^2 to 10^7 n/cm^{2}sec. It consists of the compensated ion chamber, the logarithmic current amplifier (10^{-12} to 10^{-7} amp), the periodmeter (−30 sec, ∞, +3 sec), and the safety trip circuit (in the ranges 15 to 6 sec and 6 to 3 sec) which can be preset at a warning and at an alarm level. (auth)

26900 (PAN-417/XII) LINEINYI, TOKOVYI KANAL "V" SYSTEMY UPRAVLENIYA I ZASHCHITY REAKTORA NULEVOI MOSHCHNOSTI ANNA. (A Linear d-c Channel "B" of the Control and Safety System for Zero Power Reactor ANNA). Tadeush Zelinski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 15p.

A measuring system for the control of neutron flux in two decades and for the signalization of the preset flux level overshoot is described. The system consists of 3 identical measurement channels operating on the principle "two-out-of-three". Component parts of the electronics equipment of the system, such as a d-c electrometer amplifier, trigger circuits of the power level to overcome signalization, and the circuits for signalization, of mismatch of the voltages at the outputs of 3 amplifiers, are described. Results of testing the main system parameters are given. (auth)

26901 (RT/FI(63)6) SU UNA POSSIBILE MODIFICA DELLA COLONNA TERMALIZZANTE DEL REATTORE RC-1. (Possible Modification of Reactor RC-1 Thermalizing Column). G. Focaccia, M. Marseguerra, V. Modigliani, and G. Pauli (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Fisica Nuclear Applicata, Rome). Jan. 1963. 23p.

The improvement of the nuclear characteristics of the RC-1 reactor thermalizing column is considered. There is the possibility of varying the characteristics of thermic flux and R_{Cd} by a partial or total replacement of the graphite with beryllium oxide. (auth)

26902 (SCTM-284-62(53)) POWER CALIBRATION OF THE SANDIA PULSED REACTOR. J. A. Snyder and W. E. Taylor (Sandia Corp., Albuquerque, N. Mex.). Jan. 1963. Contract [AT(29-1)-789]. 17p.

The power recording instruments of the Sandia Pulsed Reactor (SPR) were calibrated at low-power (0.1 to 2.5 watts), continuous operation with the reactor at the outdoor site. A boron-trifluoride neutron detector in a moderator of paraffin was used to compare the intensity of an NBS reference neutron source and the recorded neutron intensity of the reactor at a constant, but arbitrary, power level. The reactor power level recorded was subsequently calculated from the measured neutron intensity of the reactor source and was related to the recorder response. An independent determination of the power calibration by measuring the reactor neutron intensity with energy-threshold foil detectors differed by 10%. A calibration of the power recorders with the reactor at the indoor site was also made at low-power levels using foil threshold detectors. Using foil threshold detectors, the power level calibration at the indoor site differed by 25% from the calibration at the outdoor site. The origin of the difference between the indoor and outdoor power calibration was the backscatter of neutrons by the reactor building walls. (auth)

26903 (TID-15532) NOISE IN THE MEASUREMENT OF SMALL REACTIVITY CHANGES. R. L. Long and E. F. Bennett (Argonne National Lab., Ill.). Feb. 1962. Contract [W-31-109-eng-38]. 3p. (UAC-6142)

A reactivity measuring system that uses a weakly absorbing automatic control rod was constructed for use with the Argonne Thermal Source Reactor. At a fixed fission rate, the auto rod exhibits a random motion attributable to neutron chain statistics (pile noise) superimposed on a tendency to long-term drift. Pile noise diminishes as the fission rate is increased. The drifts, due mostly to temperature effects, were substantially reduced by regulating the temperature difference between core and shield. Satisfactory operation of the entire system was checked by an

experimental determination of noise in the auto-rod motion and by comparing this result with the value predicted theoretically. Because of the random time behavior of rod position, an electronic integrator was used to obtain averages over intervals of 100 sec. (M.C.G.)

26904 PLANNING AND EXECUTION OF CONSTRUCTION WORK ON THE FR-2. A. Bauer. Atomwirtschaft, 8: 229-34(Apr. 1963). (In German)

The planning of the FR-2 reactor building, biological shielding, and auxiliary buildings is described. Topics covered include: pressure and gas tightness of the building, sealing against liquids, surface treatment, concrete shielding, operations building, electric center, reservoir for radioactive wastes, cooling towers, storage building for fuel elements and radioactive materials, and chimneys for outgoing air. Erection and testing of the buildings are discussed. (M.C.G.)

26905 PRODUCTION AND QUALITY PROBLEMS IN CONSTRUCTION OF FR-2. H. Gallenberger. Atomwirtschaft, 8: 237-40(Apr. 1963). (In German)

Difficulties in the manufacture of the aluminum reactor tank and in the lead coating of the outer steel tank for the FR-2 are described. Procedures for quality control are discussed. Diagrams are included. (M.C.G.)

26906 ZERO POWER MEASUREMENTS ON FR-2. K. H. Beckurts, W. Glauner, S. Hagen, M. Kuechle, H. Meister, and D. Wintzer. Atomwirtschaft, 8: 249-50 (Apr. 1963). (In German)

An extensive program of physical measurements was carried out on the FR-2 at zero power from March to September 1961. The first critical experiment, reactivity measurements, and measurements of neutron flux distribution are described. (M.C.G.)

26907 THE STARTUP OF THE FR-2. M. Diederichs and W. Eisermann. Atomwirtschaft, 8: 251-4(Apr. 1963). (In German)

Preparations for the zero-energy measurements included testing the tightness of the circulation system, drying it, and filling it with heavy water. Measurements were made of the power jump by means of reactivity disturbances and of the effects of boron poisoning. Tests were also carried out on non-nuclear parts of the reactor. Preparations were made for power startup and on December 17, 1962, the rated power of 12 Mw was achieved. (M.C.G.)

26908 THE ARGONAUT REACTOR AT KARLSRUHE. Chr. Brueckner, H. Meister, and E. Risse. Atomwirtschaft, 8: 260-4(Apr. 1963). (In German)

On January 11, 1963, the Argonaut Reactor began operation as a second research reactor at Karlsruhe. The design, construction, characteristics, and auxiliary equipment are described. The reactor is characterized by great flexibility and safety. After completion of the zero-energy experiments it is to be extended into the coupled Karlsruhe fast-thermal Argonaut Reactor (STARK). This arrangement will be used for experiments with fast neutrons. (M.C.G.)

26909 PHYSICAL ASPECTS OF THE HOMOGENEOUS SUSPENSION REACTOR PROJECT. J. A. H. Kersten. Atoomenergie Haar Toepassingen, 5: 41-50(Mar. 1963). (In Dutch)

A brief description is given of the construction of a homogeneous suspension reactor. The results obtained from sub-critical experiments are summarized. (tr-auth)

26910 CHEMICAL ASPECTS OF THE HOMOGENEOUS SUSPENSION REACTOR PROJECT. M. E. A. Hermans. Atoomenergie Haar Toepassingen, 5: 63-71(Apr. 1963). (In Dutch)

The chemical problems occurring in the development of the homogeneous suspension reactor are many and excessively diverse in nature. Typical problems of the suspension reactor are illustrated in this review. The topics discussed are fuel preparation, radiation stability of the fuel elements, colloid-chemical stability of the suspension, energy range of the fission products in the UO_2, erosive properties of the fuel suspension, removal of the fission products, and caking. (tr-auth)

26911 THE MONTECUCCOLINO RB-1 REACTOR. Bruno Ferretti (Università, Bologna), Ferrante Pierantoni, Paolo Aiello, Piero Azzoni, Domenico Brini, Franco Casali, Gianfranco Falcinelli, Raimondo Manzini, and Agostino Salomoni. Comit. Naz. Energia Nucl., Notiziario, 9: 40-9(Mar. 1963). (In Italian)

The RB-1 reactor is a graphite-moderated and -reflected reactor with enriched UO_2 as fuel. It is designed to operate at low power with natural convection cooling. A general description is given of the reactor, and the safety and control circuits are discussed. (J.S.R.)

26912 POSSIBLE WAY OF INCREASING THE PERFORMANCE OF THE 2MW VVRS RESEARCH REACTOR. István Szentgyoergyi. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 127-38(1963). (In Hungarian)

Some physical experiments and the need to speed up the isotope production, make it desirable to increase the power of the VVRS reactor from 2 to 10 Mw. The obstacle preventing this is that the heat output of the fuel elements cannot be but slightly increased owing to the presently poor convectional heat transfer rate in the reactor. Problems of power increase in particular, with the possibility of applying surface boiling heat transfer are discussed, but technological problems e.g. distortion of fuel rods, thermal-stresses, corrosion, strength problems, dosimetry, secondary cooling system etc., are omitted. It is to be noted that even if the engineering problems of power increase are solved, the power rise can be effected only after these problems are thoroughly investigated. (auth)

26913 HECTOR. THE PHYSICS PROGRAMME. R. Richmond (Atomic Energy Establishment, Winfrith, Dorset, Eng.). Nucl. Eng., 8: 206-7(June 1963).

Hector was designed for measuring the nuclear behavior of reactor materials by the oscillation technique. The program will involve the study of the self-screening effect of Pu in plutonium-bearing fuel elements and in irradiated elements. (D.L.C.)

26914 HECTOR. DESIGN CHANGES AND CONSTRUCTION EXPERIENCE. Nucl. Eng., 8: 207-11(June 1963).

The main features of Hector are described briefly. The design changes involved the use of two rather than three graphite walls between the two core regions, and the monitoring of the gas circuit. Instrumentation and control are discussed. The construction and commissioning of the reactor are described. (D.L.C.)

26915 THE KINETIC BEHAVIOR OF THE COUPLED REGIONS OF THE UTR-10 REACTOR. Richard A. Danofsky and Robert E. Uhrig (Iowa State Univ. of Science and Tech., Ames). Nucl. Sci. Eng., 16: 131-3(May 1963).

The effects of flux tilting on the kinetic behavior of the two-fuel region UTR-10 reactor were studied using an analog computer. The reactor response to step and ramp inputs of reactivity to one region and to sinusoidal variation of the coupling was studied. It is concluded that: (1) both fuel regions exhibit the same stable reactor period, (2) effects of flux tilting on control rod worth should not be significant, (3) the ϕ_1/ϕ_2 ratio varies from 1.05 to 1.18

for an excess reactivity of 0.48%, and (4) the response to a sinusoidal variation of coupling is similar to that of a single-region reactor to a sinusoidal variation of reactivity. (D.L.C.)

26916 THE UNIVERSITY OF FLORIDA NUCLEAR RESEARCH CENTER. Robert E. Uhrig (Univ. of Florida, Gainesville). Res. Reactor J., 3: No. 3, 1-5(1963).

The University of Florida Training Reactor, a 10-kw Argonaut-type reactor, is described and the facilities and programs involved in its use are outlined. The educational experiments and research projects carried out on the reactor are described. (D.L.C.)

26917 THE CHECKERBOARD POOL CORE. M. N. Aybers (Atomic Energy Commission, Ankara) and G. J. Hefferon. Res. Reactor J., 3: No. 3, 6-10(1963).

The Checkerboard Pool Core, an alternating array of standard MTR-type fuel elements and graphite moderator pieces, was developed to minimize accidential droppings of fuel elements into the core. The core also has some desirable characteristics, e.g., a flexible leakage spectrum, a larger (9 × 6) array required for 1-Mw operation, and a longer neutron lifetime (~100 μsec). Critical experiments, rod worth measurements, and flux measurements made with this type of core are reported. (D.L.C.)

26918 MONITORING FOR FISSION PRODUCT RELEASE AT THE IRL REACTOR. K. W. Skrable and M. P. Doyle (Columbia Univ., New York). Res. Reactor J., 3: No. 3, 11-13(1963).

A description is given of the IRL reactor, a 5-Mw pool research reactor. The holdup tank vent system has a carbon-bed filter system to prevent release of fission products in case of an accident, and an ion chamber is used to monitor the activity on the filters. In loading and unloading of the reactor, fluctuations of the radiation level of the filters were observed and found to be due to a leading fuel element. (D.L.C.)

26919 MEASUREMENTS OF THE TRANSFER FUNCTION OF THE UNIVERSITY OF FLORIDA TRAINING REACTOR. T. F. Parkinson (Univ. of Florida, Gainesville). Res. Reactor J., 3: No. 3, 14-20(1963).

The transfer function of the Training Reactor was measured by the pile oscillator method and the random noise method. The results are plotted as phase shift, gain, and output power vs frequency. The prompt neutron lifetime is found to be 258 ± 20 μsec. (D.L.C.)

26920 A GUIDE FOR IRRADIATIONS IN THE UNIVERSITY OF FLORIDA TRAINING REACTOR. L. D. Butterfield (Univ. of Florida, Gainesville) and A. R. Boynton. Res. Reactor J., 3: No. 3, 21-3(1963).

A sample graph of the neutron flux along the center vertical port is given. The UFTR irradiation facilities are described. The calculation of activities and reactivity changes is considered briefly. The procedures for obtaining irradiations in the UFTR are outlined. (D.L.C.)

SPACE APPLICATIONS AND TECHNOLOGY

Refer also to abstracts 26018, 26100, and 26101.

26921 (AFSWC-TDR-62-121) HIGH-TEMPERATURE DESTRUCTIVE TESTING OF PLUTONIUM-FUELED CAPSULES FOR A THERMOELECTRIC CONVERTER. John C. Clifford (Air Force Special Weapons Center, Kirtland AFB, N. Mex.). May 1963. 49p.

Plutonium fuel capsules, designed for use in a thermoelectric SNAP device, were exposed to high-temperature oxidizing environments to evaluate the effects of capsule integrity and to determine the quantity and characteristics of alpha activity released during destruction of capsules. For test purposes plutonium-239 was substituted for the normal plutonium-238 fuel charge. Capsules which survived the tests were examined by radiographic and metallographic techniques to determine the degree of damage sustained. Residues from destroyed capsules and filter papers from a 90° segment, 800-meter air-sampling network were analyzed radiochemically to determine the quantities and characteristics of the released alpha activity. Because of the confined test configuration, massive alloying of plutonium and capsule components was observed when capsules were destroyed. As a result the fraction of plutonium which escaped to the atmosphere was small, on the order of 10^{-4} of the initial charge. From cascade impactor samples of this airborne debris it was estimated that 90% of the alpha activity was associated with material of 1.5 micron median diameter or less. (auth)

26922 (NASA-TN-D-1570) ORBIT-LAUNCHED NUCLEAR VEHICLE DESIGN AND PERFORMANCE EVALUATION PROCEDURE FOR ESCAPE AND PLANETARY MISSIONS. Ronald J. Harris and Robert E. Austin (National Aeronautics and Space Administration. George C. Marshall Space Flight Center, Huntsville, Ala.). June 1963. 66p.

A comprehensive procedure is described, and reference data presented, by which the effect of certain design parameters upon the basic performance of orbit-launched nuclear vehicles can be readily determined for escape and planetary missions. The performance parameters investigated are payload ratio, propellant ratio, characteristic velocity requirement, burning time, injection altitude, central angle, and flight-path angle. The effects of initial thrust-to-weight radio, initial altitude, specific impulse, specific weight factors, and hyperbolic excess velocity are considered. The range of specific impulse assumed is restricted to that considered practical for nuclear heat-exchanger propulsion systems. Use of this procedure and the data presented allows a quick determination of nuclear propulsion requirements for specific mission profiles from the standpoint of maximizing either payload or payload ratio. It is shown that, in general, maximum payload and maximum payload ratio are not coincident when thrust is fixed and initial weight is variable. It is shown that, for certain hyperbolic excess velocities, there is an optimum initial weight in orbit when operating with a fixed engine system within the range of thrust-to-weight ratios considered practical for nuclear heat-exchanger systems. Numerical examples are included which illustrate the methodology and indicate the degree of accuracy that can be expected of the estimation procedure. The results of the numerical examples are compared with exact computer solutions and shown to be well within the accuracy usually required in preliminary design studies. (auth)

26923 NUCLEAR POWER IN SPACE TECHNOLOGY. Atomics, 16: No. 3, 12-18(May-June 1963).

An outline is given of the Project ROVER (Kiwi, NERVA, and RIFT). The fundamental performance limitations of the ROVER reactor program and the various reactor concepts are discussed. The difficulties encountered in the Kiwi-B tests are described briefly. Finally, the NERVA and RIFT programs are discussed. (D.L.C.)

26924 SYSTEMS FOR NUCLEAR AUXILIARY POWER. Atomics, 16: No. 3, 18-23(May-June 1963).

An outline is presented of the SNAP program. The power requirements of communications satellites are examined briefly. The organization of the SNAP program is described briefly. and the characteristics of the various SNAP projects are tabulated. The radioisotope and reactor projects are discussed. particularly the SNAP-50/SPUR. (D.L.C.)

26925 PROJECT PLUTO. Atomics, 16: No. 3, 23-5 (May-June 1963).

A brief outline is presented of Project Pluto, a nuclear ramjet program. The Tory II-Al and II-C reactors are discussed. (D.L.C.)

26926 AEROSPACE PNEUMATIC CONTROL SYSTEMS. C. P. Sung and L. B. Taplin (Bendix Corp., Detroit). J. Eng. Ind., 85: 135-50(May 1963).

An attempt is made to deduce the growth pattern of aerospace pneumatic control systems, where pneumatic systems are defined as those employing any gas as a working medium. Various important applications responsible for the initial growth of these systems, such as nuclear engine controls, space attitude controls, and flight controls, are illustrated by actual development activities in the fulfillment of well-established requirements. The scope of aerospace pneumatic control systems is defined and their inherent characteristics are expressed in terms of capabilities and limitations. A brief review is made of the various configurations of both the control systems and key components. Some of the significant technological advances in the field of aerospace pneumatic control systems are described. The status and the future position of aerospace pneumatic control systems are discussed and evaluated. (auth)

26927 RADIOISOTOPE POWER SOURCES. J. P. Culwell (Atomic Energy Commission, Washington, D. C.). IAEA Preprint No. CN-14/41. 18p. (TID-18754)

To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, held in Salzburg, Austria, May 27-31, 1963.

Radioisotope power systems are particularly suited for remote applications where long-lived, compact, reliable power is needed. Able to perform satisfactorily under extreme environmental conditions of temperature, sunlight and electromagnetic radiations, these atomic batteries are attractive power sources for remote data collecting devices, monitoring systems, satellites, and other space missions. Radioisotopes used as fuels generally are either alpha or beta emitters. Alpha emitters are the preferable fuels but are more expensive and less available than beta fuels and are generally reserved for space applications. Beta fuels separated from reactor fission wastes are being used exclusively in land and sea applications at the present.

Prototype thermoelectric generators, fueled with strontium-90 and cesium-137, are now in operation in weather stations, marine navigation aids, and deep sea monitoring devices. Plutonium-238 thermoelectric generators are in orbit operating as electric power sources for TRANSIT satellite. Rigid safety requirements are established and extensive tests are conducted to insure that these systems can be employed without creating undue hazards. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 24763, 25717, 26187, and 26188.

26928 (HW-73672) DISPERSION OF 300 AREA LIQUID EFFLUENT IN THE COLUMBIA RIVER. G. E. Backman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 25, 1962. Contract AT(45-1)-1350. 20p.

Three dye tests were made to trace the liquid effluent dispersion pattern from the outfall of the Plutonium Recycle Test Reactor into the Columbia River. The concentrations of the fluorescein dye were measured at sampling locations. At the cross section nearest the proposed Richland Pumping Station the maximum concentrations were from 7 to 10 times that anticipated if complete dispersion had occurred. (C.H.)

26929 (HW-74043) BATCH CALCINATION STUDIES. An Interim Report. J. J. Shefcik (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 19, 1962. Contract AT(45-1)-1350. 21p.

Internal pressurization of a calcine container was observed only when partial melting occurs and the sulfate concentration in the waste solution is in excess of the stoichiometric sodium equivalent. Increasing the cross sectional area of a pot decreases the probability of internal pressurization. The volume reduction that results when the calcine melts leaves greater than 50% of the pot void. Solution foaming during the boil down step is a function of the boil up rate, the waste composition, and the pot geometry. In general, the tendency for foaming increases with acidity and phosphate ion concentration. Increasing the pot diameter decreases solution foaming. For a pot of a given diameter, increasing the length to diameter ratio decreases the foaming tendency. Silicone anti-foam agents occasionally reduced foaming tendencies. An air sparge helped to control foaming. The use of a draft tube within the calciner pot proved to be effective in controlling foaming. An air purged dip tube with a steam bleed proved to be reliable as a liquid level detector. The calcine can be removed from the pot by the addition of nitric acid and boiling. The volume of nitric acid required for removal diminishes as the acidity increases over the range 0 to 4M HNO_3. (auth)

26930 (ISS-63/23) CRITERI PER L'ELIMINAZIONE DEI RIFIUTI RADIOATTIVI DEI LABORATORI (EDIZIONE PROVVISORIA). Recommendations for Radioactive Waste Disposal from the Laboratories (Provisional Edition)). M. A. Di Lazzaro (Italy. Istituto Superiore di Sanità, Rome). Mar. 7, 1963. 39p.

Recommendations for the disposal of radioactive waste rising from the use of radioisotopes are presented. The origin and the nature of such waste from unsealed and sealed sources are also discussed. Criteria for the decontamination of materials and objects, in general use in the institutions managing radioisotopes are illustrated. Some of the highly toxic and generally used radioisotopes are C^{14}, P^{32}, I^{131}, Cs^{137}, Sr^{90}, and Ra^{226}. (auth)

26931 (ORNL-TM-453) UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, DECEMBER 1962. M. E. Whatley, P. A. Haas, R. W. Horton, D. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). May 20, 1963. Contract W-7405-eng-26. 47p.

A 24-in.-dia. foam column was installed for scale-up study. Precipitation of calcium and magnesium followed by foam separation for strontium removal from low level waste was studied. For the shear and leach program, particle size measurements were made on sheared thorium dioxide–uranium dioxide filled Mark I prototype fuel elements. A series of runs were started for dissolving zirconium fuel elements in a one vessel volatility flowsheet. High level waste processing run 70 using simulated Purex-65 waste was reported. (auth)

26932 (ORNL-TM-516) WASTE TREATMENT AND DISPOSAL PROGRESS REPORT FOR NOVEMBER–DECEMBER 1962, AND JANUARY 1963. F. L. Parker and R. E. Blanco (Oak Ridge National Lab., Tenn.). June 12, 1963. Contract W-7405-eng-26. 134p.

Progress is reported on developments in waste treatment and disposal in terms of: high-level-waste calcination; low-level-waste treatment; engineering, economics, and safety evaluation; disposal in deep wells; disposal in natural salt formations; Clinch River study; fundamental studies of minerals; White Oak Creek Basin study; and foam separation. (B.O.G.)

26933 (ORNL-TM-559) ESTIMATED COSTS FOR MANAGEMENT OF HIGH-ACTIVITY POWER REACTOR PROCESSING WASTES. J. O. Blomeke, J. J. Perona, R. L. Bradshaw, and J. T. Roberts (Oak Ridge National Lab., Tenn.). May 13, 1963. Contract W-7405-eng-26. 21p.

A scheme believed to be acceptably safe consists of interim storage as liquids in tanks, followed by pot calcination of the wastes to produce relatively small volumes of stable solids, interim storage of the pots, and shipment of the pots to salt mines for permanent disposal. Total costs are estimated to range from 2.6×10^{-2} to 4.8×10^{-2} mills/kwh(e) and are believed to represent an acceptable contribution to the cost of nuclear power. A 6-ton/day fuel processing plant is assumed which would handle the fuel from a 15,000-Mw(e) nuclear power economy. This plant would process 1500 ton/yr of uranium converter fuel at a burnup of 10,000 Mwd/t and 270 ton/yr of thorium converter fuel irradiated to 20,000 Mwd/t. Costs of each operation for the resulting Purex and Thorex wastes in acid and in alkaline form, and for interim storage times from 0 to 30 years, are extracted from a series of earlier studies made of individual management operations. (auth)

26934 RESOLUTION OF PROBLEMS CONCERNED WITH TREATMENT OF RADIOACTIVE WASTES. F. Duhamel. Bull. Inform. Sci. Tech. (Paris), No. 69, 3-6(Feb. 1963). (In French)

A brief review of problems concerned with the treatment of radioactive wastes is presented. The treatment of effluents at Saclay, Cadarache, and Bouchet is mentioned briefly. Actual problems of treatment reviewed are coprecipitation and ion exchange; other problems are listed. The treatment of liquids is not included. (P.C.H.)

26935 PROBLEMS CAUSED BY THE PRODUCTION OF RADIOACTIVE WASTE IN THE PARIS REGION. THE PRESENT SOLUTION. P. Cerré. Bull. Inform. Sci. Tech. (Paris), No. 69, 7-9(Feb. 1963). (In French)

Up-to-date information concerning the general evolution of the radioactive waste in the Paris region is presented. (P.C.H.)

26936 EVOLUTION OF THE LIQUID-WASTE PROBLEM IN THE CENTRES IN THE PARIS REGION. J. Bourdrez. Bull. Inform. Sci. Tech. (Paris), No. 69, 11-17(Feb. 1963). (In French)

A detailed examination of the evolution of the liquid-waste problem in the Paris region during the past five years is presented. Precise information is given on the effluent treatment station at Saclay, and the one being built at Fontenay. (P.C.H.)

26937 CONDITIONING AND STORAGE OF LARGE SIZE SOLID WASTE FROM PILES. E. Mestre. Bull. Inform. Sci. Tech. (Paris), No. 69, 19-25(Feb. 1963). (In French)

A review is presented on the various techniques developed for solving the problems of conditioning and storage of large size solid waste from reactors. (P.C.H.)

26938 THE CONDITIONING OF WEAKLY ACTIVATED SOLID WASTE MATTER AT THE MARCOULE CENTRE. J. Rodier, H. Bouzigues, and J. Cochet. Bull. Inform. Sci. Tech. (Paris), No. 69, 27-35(Feb. 1963). (In French)

Methods used in the attempt to find a practical solution in conditioning of weakly activated solid waste and to make a compromise between safety and economic considerations are described. The classification and origin of the waste are also discussed. The problem of collecting and conditioning is then dealt with. Some figures are given concerning the production of the pilot station. The financial aspects of the conditioning such as is carried out at Marcoule are also reviewed. (P.C.H.)

26939 PROBLEMS PRESENTED BY RADIOACTIVE WASTE AT THE GRENOBLE NUCLEAR RESEARCH CENTRE. E. de Robien (Centre d'Etudes Nucléaires, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 69, 37-41(Feb. 1963). (In French)

The effluents at the Grenoble Centre come from piles, very high activity laboratories, the decontamination building, and other laboratories. The liquid effluents are separated into very active, active, and suspect effluents. The active and suspect effluents are collected in tanks and according to the degree of activity are either diluted or concentrated in an evaporator where the very active effluents also arrive. The evaporator has a capacity of 1 m^3/hr and a decontamination factor of 10^6. As a result the sludges are solidifed. The solid effluents are for the most part stored, awaiting the imminent construction of an installation for concreting that will treat both irradiated loops and solidified sludges. The biological wastes and solvents are treated in a low capacity incinerator. (auth)

26940 PROBLEMS PRESENTED BY THE TREATMENT OF WEAKLY RADIOACTIVE EFFLUENTS IN AN ATOMIC CENTRE. G. Wormser. Bull. Inform. Sci. Tech. (Paris), No. 69, 43-8(Feb. 1963). (In French)

Problems arising during the realization of a treatment station for radioactive effluents are reviewed. The possibilities of evaluating the effluents of an atomic center, and the difficulties encountered in the estimation of the possibilities of discharge, are successively analyzed. Various methods of treatment, and the main particularities of the treatment stations are also examined. (P.C.H.)

26941 MIGRATION FROM A DISPOSAL OF RADIOACTIVE LIQUID IN SANDS. P. J. Parsons (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys., 9: 333-42(Mar. 1963). (In English)

A soil survey was carried out in a wooded region of the Chalk River Project where an isolated plant had been built to concentrate liquid fission products. During its operation in 1954 over 1000 gal of acid waste, containing complexing agents and over 1000 c of Sr^{90}, was poured into a pit lined with limestone. Intensive soil and groundwater sampling have located and defined a migration pattern in the groundwater. Undisturbed samples of sand were collected from beneath the water table and a multiple sampler was used to obtain sand samples for radiochemical analysis from various depths in the same hole. Ruthenium migrated rapidly from the disposal traveling at about the same rate as groundwater; this has been followed by slower-moving Sr^{90} that has developed into a continuous tongue 650 ft long and containing 800 c. It has been estimated that Sr^{90} will be released to the environment in about 130 years but that the rate of release into a nearby stream will not cause the concentrations of this radionuclide to rise above drinking-water tolerance. (auth)

26942 DECONTAMINATION OF RADIOACTIVE AQUEOUS EFFLUENT BY THE CALCIUM–FERRIC PHOSPHATE PROCESS. Colin R. Frost (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). J. Am. Water Works Assoc., 55: 581-6 (May 1963).

The calcium and ferric phosphate process for the removal of radioisotopes from solution can effect a greater than 70% removal of uranyl and strontium ions and mixed fission products, but cesium removal is poor. A pH lower than 11.5 will not appreciably reduce the effectiveness of the process. Dosing ion concentrations of 40 ppm PO_4^{3-}, 30 ppm Ca^{2-}, and 20 ppm Fe^{3+} in the waste will not appreciably reduce the effectiveness of the process. Complete precipitation of the dosing ions can be achieved at a final pH of 9.5 with concentrations of 90 ppm PO_4^{3-}, 50 ppm Ca^{2+}, and 40 ppm Fe^{3+}, or with values in the same proportions. (auth)

26943 THE COLLECTION OF SMALLER QUANTITIES OF RADIOACTIVE WASTES AND THEIR SAFEGUARDING. H.-J. Marcinowski (Isotopen-Studiengesellschaft e. V., Frankfurt am Main). Kerntechnik, 5: 157-9(Apr. 1963). (In German)

The specific problems of the small business users of radioactive substances are studied in schematizing the corresponding regulations, especially in the field of unifying the collecting, transport, storing, and concentrating with respect to the costs. (auth)

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This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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IAEA	Available from the International Atomic Energy Agency.
JCL	For sale by the Special Libraries Association Translation Center, John Crerar Library, 86 E. Randolph Street, Chicago 1, Illinois.
NAS	National Academy of Sciences, National Research Council, Washington 25, D. C.
NRC	For sale by the National Research Council of Canada, Ottawa, Ontario, Canada.
OTS	For sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C.
UKAEA, London	Available from United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S. W. 1.
USGS	Available free-of-charge from the U. S. Geological Survey, Washington 25, D. C.

(The symbols "ph," "mf," and "fs" are used to designate that copy is available only in photostat, microfilm, or facsimile (Xerox) form.)

Report No.	Abstract No.	Availability
NUMERICAL	**(Misc.)**	
57GL125*	17-25380	
AAEC-TM–	**(Australian)**	
176	17-25703	See TID-7654(p.411-20)
190	17-25842	Dep.(mc)
ACNP–		
62848&Add.1	17-26842	Dep.(mc); $21.00(fs), $9.69(mf) OTS
ACRH–		
18	17-24818	Dep.(mc); $12.00(fs), $5.15(mf) OTS
AD–	**(Misc.)**	
282000*	17-24878	$1.60(OTS)
282296*	17-25843	$4.60(OTS)
284912*	17-25386	See NESCO-P-166-10
285212*	17-25504	$1.75(OTS)
285588*	17-25725	See WADC-TR-59-575(Pt.III)
285620*	17-26664	$4.60(OTS)
288892*	17-25382	See ASD-TR-61-705
288917*	17-25381	See ASD-TDR-62-811
290341*	17-25771	See ASD-TDR-62-667
297083*	17-26266	See AFSWC-TDR-62-133
402124*	17-25844	$9.10(OTS)
402679*	17-25691	See RBESO-3404-2
403526*	17-25768	
404255*	17-25845	$2.60(OTS)
404574*	17-26665	See AFCRL-63-81
404746*	17-26267	See NRL-5896
404808*	17-24899	See USNRDL-TR-636
405168*	17-25846	$5.60(OTS)
AEC-tr–		
5700	17-25605	Dep.(mc); $1.60(fs), $0.80(mf) JCL
5811	17-25359	Dep.(mc); $4.60(fs), $1.43(mf) JCL
5824	17-25519	Dep.(mc); $2.60(fs), $1.01(mf) JCL
5827	17-25871	Dep.(mc); $1.10(fs), $0.80(mf) JCL
5828	17-26890	Dep.(mc); $3.60(fs), $1.16(mf) JCL
AECL–	**(Canadian)**	
1692	17-24739	Dep.; $5.00(AECL)
1692(Paper I)	17-24740	
1692(Paper V)	17-24741	
1711	17-25856	See PR-P-56
1752	17-26752	See CRRP-1147
AED-C–	**(German)**	
12-03	17-24831	Dep.(mc)
AEEW-R–	**(British)**	
167	17-25406	Dep.
AERE-Bib–	**(British)**	
141	17-25057	Dep.; $0.49(BIS); 3s. 6d. (HMSO)
AERE-GP–	**(British)**	
R-2475	17-26643	Dep.(mc)
AERE-M–	**(British)**	
1122	17-26771	See TID-7641(p.1-14)
AERE-R–	**(British)**	
4022	17-25407	Dep.; $0.63(BIS); 4s. 6d. (HMSO)
4097	17-25450	Quart. J. Roy. Meteorol. Soc., 89: 43-61 (1963)
4184	17-25834	Nature 198: 850-1(1963)
4292	17-25111	Dep.; $0.42(BIS); 3s. (HMSO)
4307	17-25471	Dep.; $0.63(BIS); 4s. 6d. (HMSO)
4318	17-25112	Dep.; $0.42(BIS); 3s. (HMSO)

Report No.	Abstract No.	Availability
AFCRL–	**(Non-AEC)**	
63-81	17-26665	$5.60(OTS)
AFSWC-TDR–	**(Non-AEC)**	
62-96	17-24879	
62-121	17-26921	
62-133	17-26266	$3.60(OTS)
62-137	17-25472	
63-19	17-25585	
AMRA-CR–	**(Non-AEC)**	
63-02/1(F)	17-25769	
ANL–		
6646	17-25586	Dep.; $2.75(OTS)
6669	17-26843	Dep.; $2.00(OTS)
6701	17-26749	Dep.; $2.00(OTS)
6707	17-26892	Dep.; $0.50(OTS)
6717	17-26750	Dep.; $1.75(OTS)
ANL-FGF–		
391	17-25426	Nucl. Sci. Eng. 15: 411-14(1963)
APEX–		
621	17-26751	Dep.(mc); $3.60(fs), $1.22(mf) OTS
ARF–	**(Misc.)**	
1184-9	17-25160	Dep.(mc); $4.60(fs), $1.67(mf) OTS
1193-23	17-26419	Dep.(mc); $9.60(fs), $3.80(mf) OTS
ARF-B–	**(Misc.)**	
6012-1*	17-25770	Dep.(mc)
ASD-TDR–	**(Non-AEC)**	
62-509(Vol.II)	17-25683	OTS
62-667	17-25771	$2.00(OTS)
62-811	17-25381	$0.75(OTS)
63-297	17-25684	
63-360	17-25772	
ASD-TR–	**(Non-AEC)**	
61-705	17-25382	$2.00(OTS)
AWRE-O–	**(British)**	
21/63	17-25742	Dep.(mc)
BAW–	**(Misc.)**	
1249(Vol.II)	17-26844	Dep.(mc); $9.10(fs), $3.38(mf) OTS
1277	17-26845	Dep.(mc); $1.60(fs), $0.80(mf) OTS
BMI–	**(Misc.)**	
1209	17-26846	Dep.(mc); $8.10(fs), $2.81(mf) OTS
1624(Del.)	17-25685	Dep.; $2.00(OTS)
BMI-X–		
234	17-25720	Dep.(mc); $2.60(fs), $1.01(mf) OTS
BNL–		
780	17-25473	Dep.; $2.00(OTS)
6488	17-25906	Phys. Chem. Solids 24: 617-24(1963)
6498	17-26533	Nucl. Phys. 43: 500-22(1963)
6604	17-26415	Nucl. Sci. Eng. 16: 140-2(1963)
6617	17-26577	Phys. Rev., 130: 2407-16(1963)
6636	17-25283	J. Am. Chem. Soc., 85: 1360-1(1963)
6731	17-26590	Phys. Rev. 131: 322-4(1963)
6754	17-26340	Phys. Rev. 130: 2484-94(1963)
6802	17-25805	Phys. Rev. 131: 183-90(1963)
6948	17-25286	Dep.(mc); $2.60(fs), $0.86(mf) OTS
6952	17-25540	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6953	17-25541	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6957	17-26283	Dep.(mc); $1.60(fs), $0.80(mf) OTS

Report No.	Abstract No.	Availability
6960	17-24832	Dep.(mc); $1.60(fs), $0.80(mf) OTS
BNL-T-		
296	17-25473	See BNL-780
CEA-	**(French)**	
2196	17-25408	Dep.(mc)
2264	17-26666	Dep.(mc)
2266	17-25542	Dep.(mc)
2269	17-26667	Dep.(mc)
2270	17-25666	Dep.(mc)
2282	17-24880	Dep.(mc)
CEA-tr-	**(French)**	
A-1231	17-25667	Dep.(mc); $3.60(fs), $1.25(mf) JCL
CERN-	**(European Organization for Nuclear Research)**	
63-10	17-25543	Dep.(mc)
63-13	17-26420	Dep.(mc)
CLOR-	**(Polish)**	
13	17-25474	Dep.
16	17-25505	Dep.
CN-		
14/18	17-25339	To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, Salzburg, Austria, May 27–31, 1963
CDO-		
227	17-24881	Dep.(mc); $15.50(fs), $7.40(mf) OTS
CRRP-	**(Canadian)**	
1147	17-26752	Dep.; $1.00(AECL)
CU-	**(Misc.)**	
34-63-AEC-1019-CHEM	17-26426	See NYO-10387
CVNA-	**(Misc.)**	
158	17-26847	Dep.(mc); $10.10(fs), $3.95(mf) OTS
162	17-26848	Dep.(mc); $8.10(fs), $2.78(mf) OTS
DC-	**(Misc.)**	
60-9-123	17-25721	Dep.(mc); $2.60(fs), $0.83(mf) OTS
DLCS-		
3570107	17-26849	Dep.(mc); $1.10(fs), $0.80(mf) OTS
3570303	17-26850	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3570401	17-26851	Dep.(mc); $1.10(fs), $0.80(mf) OTS
3990105	17-26852	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3990243	17-26853	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3990306	17-26854	Dep.(mc); $1.60(fs), $0.80(mf) OTS
DPSPU-		
63-30-6	17-25113	Dep.(mc); $2.60(fs), $0.95(mf) OTS
DRCL-	**(Canadian)**	
403	17-25616	Can. J. Chem. 41: 1575-7(1963)
DRI-	**(Misc.)**	
2099	17-25773	Dep.(mc); $2.60(fs), $1.01(mf) OTS
EFINS-	**(Misc.)**	
62-67	17-26353	Phys. Rev. 131: 461-70(1963)
EOS-	**(Non-AEC)**	
3110-Q-1	17-25843	See AD-282296
3410-Q-2	17-25779	See NP-12891

Report No.	Abstract No.	Availability
ER-	**(Misc.)**	
6219*	17-25776	See NP-12812
EUR-	**(European Atomic Energy Community)**	
4.e	17-26753	Dep.(mc)
6.e	17-24742	Dep.(mc)
10.e	17-26421	Dep.(mc)
13.e	17-26754	Dep.(mc)
20.e	17-25544	Dep.(mc)
22.e	17-26390	Dep.(mc)
23.e	17-26755	Dep.(mc)
24.e	17-26756	Dep.(mc)
25.e	17-26757	Dep.(mc)
30.e	17-25545	Dep.(mc)
33.e	17-25281	Dep.(mc)
34.f	17-25726	See EURAEC-675
35.f	17-25727	See EURAEC-676
36.f	17-25728	See EURAEC-677
37.f	17-25729	See EURAEC-678
38.f	17-25730	See EURAEC-679
39.e	17-25743	Dep.(mc)
82.f	17-25360	For translation see EURAEC-570
85.e	17-26855	Dep.(mc)
105.e	17-26391	Dep.(mc)
110.e	17-26758	Dep.(mc)
116.d	17-25686	Dep.(mc)
122.e	17-26422	Dep.(mc)
183.e	17-24743	Dep.(mc)
206.e	17-26759	Dep.(mc)
260.e	17-26802	Energia Nucl. (Milan) 9: 628-34(1962)
EURAEC-		
455	17-25722	See GEAP-3999
570	17-25360	Dep.(mc); $9.10(fs), $3.44(mf) OTS
640	17-25409	See GEAP-4228
642	17-25829	See GEAP-3771-8
666	17-25773	See DRI-2099
675	17-25726	Dep.(mc); $7.60(fs), $2.33(mf) OTS
676	17-25727	Dep.(mc); $2.60(fs), $0.92(mf) OTS
677	17-25728	Dep.(mc); $3.60(fs), $1.16(mf) OTS
678	17-25729	Dep.(mc); $3.60(fs), $1.40(mf) OTS
679	17-25730	Dep.(mc); $4.60(fs), $1.58(mf) OTS
F-	**(Misc.)**	
B1994	17-25416	See TID-18717
GA-	**(Misc.)**	
3125	17-26423	Dep.; $0.75(OTS)
3349	17-25161	Dep.; $1.25(OTS)
3853	17-26392	Dep.; $1.75(OTS)
4130	17-26893	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4147*	17-25847	
4173*	17-25687	
4190*	17-25828	
GC(V)/INF.	**(International Atomic Energy Agency)**	
38	17-26856	Dep.(mc)
GEAP-	**(Misc.)**	
3771-8	17-25829	Dep.(mc); $8.60(fs), $3.20(mf) OTS
3962	17-26857	Dep.; $3.00(OTS)
3999	17-25722	Dep.; (OTS)
4219	17-26858	Dep.(mc); $5.60(fs), $1.97(mf) OTS
4228	17-25409	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEMP-		
177A	17-25688	Dep.; $3.00(OTS)
GNEC-		
174	17-26859	Dep.(mc); $4.60(fs), $1.46(mf) OTS

Report No.	Abstract No.	Availability
HASL–		
134	17-25114	Dep.; $0.50(OTS)
HE–	**(Misc.)**	
150-211*	17-26668	
HPR–	**(Norwegian)**	
29	17-26820	Dep.(mc)
HW–		
73672	17-26928	Dep.(mc); $1.60(fs), $0.80(mf) OTS
74043	17-26929	Dep.(mc); $2.60(fs), $0.83(mf) OTS
77291	17-25744	Dep.; $0.50(OTS)
77767	17-26280	Dep.(mc); $1.10(fs), $0.80(mf) OTS
HW-SA–		
2857	17-24866	Limnol. Oceanog., 8: 305-9(1963)
2915	17-26760	Dep.(mc); $2.60(fs), $0.92(mf) OTS
3000	17-25830	Dep.(mc); $5.60(fs), $1.91(mf) OTS
3007	17-26761	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3015	17-25475	Dep.(mc); $1.60(fs), $0.80(mf) OTS
I–	**(Misc.)**	
A2049-18	17-25389	See TID-18667
A2049-20	17-25390	See TID-18691
IA–	**(Non-AEC)**	
741	17-26762	Dep.(mc)
805	17-26568	Phys. Rev., 130: 2352-60(1963)
807	17-26567	Phys. Rev. 130: 2349-51(1963)
827	17-26424	Dep.(mc)
IDO–		
28605	17-25723	Dep.; $2.25(OTS)
IFA-FT–	**(Rumanian)**	
43	17-25848	Dep.(mc)
IFA-M–	**(Rumanian)**	
27	17-26644	Dep.(mc)
31	17-26645	Dep.(mc)
IS–		
572	17-25185	Inorg. Chem., 2: 460-3(1963)
611	17-25944	Phys. Rev. 131: 255-8(1963)
ISS–	**(Italian)**	
63/20	17-25598	Dep.(mc)
63/21	17-25546	Dep.(mc)
63/23	17-26930	Dep.(mc)
JPRS–	**(Non-AEC)**	
18939	17-25731	OTS
19324	17-25169	$0.50(OTS)
19355	17-24900	$0.50(OTS)
19363	17-25044	$0.75(OTS)
19423	17-24849	$1.00(OTS)
19545	17-25520	$0.50(OTS)
KR–	**(Norwegian)**	
35(Vol.III)	17-26861	Dep.(mc)
LADC–		
5192	17-25547	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5486	17-25162	Dep.(mc); $2.60(fs), $0.83(mf) OTS
5499	17-25969	Proc. Lunar Planetary Explor. Colloq., Santa Monica, Calif., 1962, 3: No. 1, 117-34(1963)
5508	17-26413	Nucl. Sci. Eng. 16: 118-23(1963)
5509	17-26719	Phys. Rev. 131: 24-9(1963)
5552	17-25915	Phys. Fluids, 6: 648-52(1963)
5560	17-25202	J. Electrochem. Soc., 110: 587-8(1963)
5607	17-25710	At. Energy Rev., 1: No. 2, 3-36(1963)
5636	17-26572	Phys. Rev., 130: 2380-3(1963)
5668	17-25957	Phys. Rev. Letters 10: 429-31(1963)
5790	17-25115	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5791	17-25849	Dep.(mc); $2.60(fs), $0.83(mf) OTS
5792	17-25383	Dep.(mc); $2.60(fs), $1.04(mf) OTS
6180	17-25201	J. Electrochem. Soc., 110: 560-3(1963)
LAMS–		
2856	17-26393	Dep.; $2.75(OTS)
2870	17-25476	Dep.; $0.50(OTS)
2883	17-26394	Dep.; $2.75(OTS)
MATT–		
162	17-25548	Dep.; $0.50(OTS)
MCW–		
1478	17-25346	Dep.; $2.50(OTS)
MND-MD–		
2560-7	17-26862	Dep.(mc); $11.50(fs), $4.79(mf) OTS
2560-8	17-26863	Dep.(mc); $9.60(fs), $3.59(mf) OTS
MPR-XIII–		
4-63	17-25415	See TID-18706
NAA-SR–		
7455	17-25384	Dep.; $2.50(OTS)
7875	17-25410	Dep.; $1.25(OTS)
NAA-SR-Memo–		
8074	17-24744	Dep.(mc); $2.60(fs), $0.89(mf) OTS
8145	17-25549	Dep.(mc); $3.60(fs), $1.13(mf) OTS
8336	17-25774	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NARF–	**(Non-AEC)**	
62-18T	17-25477	
NAS-NRC–	**(Non-AEC)**	
1075	17-25456	253p. of "Nuclear Geophysics" Nuclear Science Series Report Number 38. Washington, D. C., National Academy of Sciences–National Research Council, 1963. $2.75
NASA-TN–	**(Misc.)**	
D-1321*	17-25385	$0.75(OTS)
D-1570*	17-26922	$2.00(OTS)
D-1597*	17-25116	$0.50(OTS)
D-1734*	17-26669	
NASA-TR–	**(Non-AEC)**	
R-170	17-25850	
R-172	17-26670	
NCSC–	**(Misc.)**	
2477-3	17-25506	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NESCO-P–	**(Non-AEC)**	
166-10	17-25386	$12.00(OTS)
NLCO–		
872	17-25347	Dep.(mc); $3.60(fs), $1.22(mf) OTS
NMI–	**(Misc.)**	
2115	17-25689	Dep.(mc); $2.60(fs), $0.83(mf) OTS
7246	17-25775	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NOL-TR–	**(Non-AEC)**	
62-155	17-26763	

Report No.	Abstract No.	Availability
NP–	**(AEC File No. for Non-AEC Reports)**	
12748	17-24745	Dep.(mc)
12799	17-25478	
12800	17-25851	Dep.(mc)
12803	17-25550	Dep.(mc)
12804	17-25357	Dep.(mc)
12807	17-25430	Dep.(mc)
12808	17-26671	Dep.(mc)
12812	17-25776	
12869	17-26864	Dep.(mc); $8.10(fs), $2.69(mf) OTS
12870	17-25551	Dep.(mc)
12871	17-25479	Dep.(mc)
12873G	17-26865	
12874	17-25777	
12877	17-25852	
12878	17-25778	
12879(Rpt.4)	17-25480	$0.30(GPO)
12881	17-26284	Dep.(mc)
12882	17-26285	Dep.(mc)
12886	17-26425	Dep.(mc)
12891	17-25779	
12892	17-26894	Dep.(mc); $10.50(fs), $4.28(mf) OTS
NRC–	**(Canadian)**	
7301	17-25289	Can. J. Chem. 41: 1463-81(1963)
NRL–	**(Misc.)**	
5896*	17-26267	$1.60(OTS)
NSEC–		
93	17-24847	Dep.(mc); $2.60(fs), $1.07(mf) OTS
NYO–		
9329	17-25745	Dep.(mc); $2.60(fs), $0.95(mf) OTS
10256	17-26349	Phys. Rev. 131: 396-406(1963)
10260	17-26371	Phys. Rev. Letters, 10: 423-5(1963)
10280	17-26866	Dep.(mc); $5.60(fs), $1.85(mf) OTS
10387	17-26426	Dep.(mc); $8.10(fs), $2.72(mf) OTS
10451	17-24892	Dep.; $3.00(OTS)
10472	17-25690	Dep.(mc); $6.60(fs), $2.09(mf) OTS
10493 & Add.1	17-26842	See ACNP-6284 & Add.1
10584	17-26672	Dep.(mc); $8.60(fs), $3.14(mf) OTS
ORNL–		
3115	17-24833	Dep.; $2.50(OTS)
3359	17-26895	Dep.; $2.00(OTS)
3382	17-26764	Dep.; $2.00(OTS)
3408	17-25058	Dep.; $2.25(OTS)
3417	17-25059	Dep.; $4.00(OTS)
3419	17-26765	Dep.; $2.75(OTS)
3421	17-26766	Dep.; $1.50(OTS)
3425	17-26427	Dep.; $2.75(OTS)
3439	17-25411	Dep.; $1.75(OTS)
3442	17-25387	Dep.; $1.25(OTS)
ORNL-TM–		
453	17-26931	Dep.(mc); $4.60(fs), $1.61(mf) OTS
472	17-25117	Dep.(mc); $1.10(fs), $0.80(mf) OTS
516	17-26932	Dep.(mc); $10.50(fs), $4.22(mf) OTS
535	17-25780	Dep.(mc); $2.60(fs), $1.01(mf) OTS
552	17-26741	Dep.(mc); $3.60(fs), $1.31(mf) OTS
557	17-26867	Dep.(mc); $5.60(fs), $1.82(mf) OTS
559	17-26933	Dep.(mc); $2.60(fs), $0.83(mf) OTS
565	17-25388	Dep.(mc); $1.60(fs), $0.80(mf) OTS
588	17-25746	Dep.(mc); $3.60(fs), $1.40(mf) OTS
OTS–	**(Misc.)**	
63-21697*	17-25731	For translation see JPRS-18939
63-21879*	17-25169	For translation see JPRS-19324
63-21895*	17-24900	For translation see JPRS-19355
63-21900*	17-25044	For translation see JPRS-19363
63-21923*	17-24849	For translation see JPRS-19423
63-21974*	17-25520	For translation see JPRS-19545
PAN–	**(Polish)**	
101/IX	17-26395	Dep.
104/IX	17-26896	Dep.
105/IX	17-26281	Dep.
106/IX	17-26767	Dep.
107/IX	17-26396	Dep.
109/XI	17-26897	Dep.
231	17-26460	Dep.
241	17-26461	Dep.
246	17-26397	Dep.
344/IX	17-26768	Dep.
367/VI	17-26462	Dep.
371/V	17-25831	Dep.
372/V	17-25853	Dep.
374/VI	17-26463	Dep.
376/VI	17-26286	Dep.
377/I-B,IX	17-25599	Dep.(mc)
380/VI	17-25600	Dep.
381/I-B	17-25854	Dep.
388/VI	17-26268	Dep.
395/VII	17-26287	Dep.
397/VI	17-26464	Dep.
398/VI	17-26269	Dep.
400/I	17-26465	Dep.
401/VII	17-26288	Dep.
403/IX	17-26398	Dep.
404/II	17-25163	Dep.
407/IX	17-26466	Dep.
408/IX	17-25601	Dep.
411/IX	17-25602	Dep.
412/IX	17-26898	Dep.
415/XII	17-26899	Dep.
417	17-26900	Dep.
PATENTS	**(Czech.)**	
9982	17-25344	
PATENTS	**(German)**	
1,109,653	17-25667	For French translation see CEA-tr-A-1231
1,145,278	17-26819	
1,145,635	17-26882	
1,146,597	17-26820	
1,146,598	17-26883	
1,146,987	17-26821	
1,146,988	17-26822	
1,146,990	17-26663	
1,147,241	17-26884	
1,147,330	17-26885	
1,147,331	17-26886	
PATENTS	**(U. S.)**	
3,083,298	17-25400	
3,086,257	17-25401	
3,086,840	17-25349	
3,086,841	17-25350	
3,086,842	17-25351	
3,086,860	17-25718	
3,086,931	17-26823	
3,086,933	17-26887	
3,086,934	17-26824	
3,087,055	17-25660	
3,087,058	17-25427	
3,087,060	17-25661	
3,087,061	17-25580	
3,087,064	17-25402	
3,087,112	17-25581	
3,087,113	17-25582	
3,087,632	17-25403	

Report No.	Abstract No.	Availability
3,087,704	17-25404	
3,087,779	17-25374	
3,087,780	17-25352	
3,087,791	17-25675	
3,087,792	17-25279	
3,087,873	17-25719	
3,087,878	17-26825	
3,087,880	17-25109	
3,087,882	17-26826	
3,087,884	17-26827	
3,087,885	17-26828	
3,087,886	17-26829	
3,087,948	17-25353	
3,088,027	17-25428	
3,088,030	17-25662	
3,088,032	17-25503	
3,088,036	17-25583	
3,088,758	17-25405	
3,088,798	17-25375	
3,088,799	17-25376	
3,088,805	17-25280	
3,088,822	17-25354	
3,088,897	17-26830	
3,088,898	17-26831	
3,088,899	17-26832	
3,088,900	17-26833	
3,088,901	17-26834	
3,088,902	17-26835	
3,088,903	17-26836	
3,089,031	17-25429	
3,089,068	17-26253	
3,092,445	17-25355	
3,092,446	17-25377	
3,092,447	17-25356	
3,092,449	17-25378	
3,092,560	17-25539	
3,092,561	17-25345	
3,092,562	17-26888	
3,092,563	17-25840	
3,092,564	17-25841	
3,092,565	17-26837	
3,092,588	17-25110	
3,092,590	17-25767	
3,092,723	17-25663	
3,092,724	17-25584	
3,092,747	17-25664	
3,092,819	17-26838	
3,093,452	17-25379	
3,093,562	17-26839	
3,093,566	17-26840	
3,093,569	17-26740	
3,093,653	17-26841	
3,093,733	17-26254	
3,093,738	17-25665	
3,094,869	17-25470	
PG-Report–	**(British)**	
251	17-25118	Dep.; $0.56(BIS); 4s. (HMSO)
PNE–	**(Misc.)**	
201F	17-24746	Dep.; $1.25(OTS)
225P	17-24747	Dep.; $1.50(OTS)
PPAD–		
482D	17-26289	Dep.(mc); $2.60(fs), $0.95(mf) OTS
483D	17-26290	Dep.(mc); $1.60(fs), $0.80(mf) OTS
484D	17-25855	Dep.(mc); $1.60(fs), $0.80(mf) OTS
485-F	17-25603	Dep.(mc); $4.60(fs), $1.70(mf) OTS
PR-P–	**(Canadian)**	
56	17-25856	Dep.; $2.00(AECL)
PRWRA-GNEC–		
7	17-26868	Dep.(mc); $5.60(fs), $2.00(mf) OTS
PUC–		
1963-103	17-26556	Phys. Letters, 4: 338-40(1963)
PWAC–	**(Misc.)**	
393	17-26769	Dep.; $0.75(OTS)
R–	**(Misc.)**	
8-62-3*	17-26664	See AD-285620
62SD94*	17-25862	
63SD43*	17-25863	
RAS–	**(Misc.)**	
33*	17-26399	
RBESO–	**(Non-AEC)**	
3404-2	17-25691	$5.60(OTS)
RFP–		
315	17-26282	Dep.; $0.50(OTS)
RISÖ–	**(Danish)**	
39	17-25431	Dep.(mc)
RT-FI–	**(Italian)**	
(63)6	17-26901	Dep.(mc)
RT/ING–	**(Italian)**	
(63)1	17-25412	Dep.(mc)
SAN–		
1005	17-25552	Dep.(mc); $6.60(fs), $2.06(mf) OTS
1007	17-25413	Dep.(mc); $19.75(fs), $9.25(mf) OTS
SCDR–		
82-63	17-25747	Dep.(mc); $1.10(fs), $0.80(mf) OTS
SCR–		
180	17-24748	Dep.(mc); $10.10(fs), $3.92(mf) OTS
SCTM–		
58-63(91)	17-25864	Dep.(mc); $16.00(fs), $7.70(mf) OTS
284-62(53)	17-26902	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SIT–		
P84	17-26673	Dep.(mc); $2.60(fs), $0.86(mf) OTS
P87	17-26674	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SLAC–		
15	17-26646	Dep.; $1.25(OTS)
SRO–		
70	17-25358	Dep.(mc); $16.00(fs), $7.67(mf) OTS
STI-DOC–	**(International Atomic Energy Agency)**	
10/16	17-24749	Dep.(mc); $1.00; Sch 21; 6s. stg; NF 4; DM 3.20; IAEA
STI-PUB–	**(International Atomic Energy Agency)**	
64(Vol.I)	17-25525	$8.50; 178.50s; NF 34; DM 29.80 (IAEA)
64(Vol.I)(p.285-304)	17-25519	For translation see AEC-tr-5824
64(Vol.II)	17-25535	$5.50; 115.50s; NF 22; DM 19.20 (IAEA)
TID–		
4005(Pt.2A)	17-25093	Dep.(mc); $3.50(OTS)
7641	17-26770	Dep.; $4.50(OTS)
7654	17-25692	Dep.; $6.00(OTS)
7657	17-25507	Dep.; $2.00(OTS)

Report No.	Abstract No.	Availability
11734	17-26869	Dep.(mc); $21.00(fs), $9.64(mf) OTS
15293	17-25228	Pure Appl. Chem., 6: 23-47(1963)
15532	17-26903	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16152	17-25363	J. Inorg. Nucl. Chem., 25: 581-94(1963)
16881	17-24982	Radiation Res., Suppl. 3, 153-70(1963)
16932	17-25396	Nucl. Sci. Eng. 15: 415-28(1963)
16934	17-25305	Nucl. Sci. Eng. 15: 458-67(1963)
16935	17-25897	Nucl. Sci. Eng. 15: 451-7(1963)
17428	17-25187	Inorg. Chem., 2: 492-5(1963)
17684	17-25889	J. Opt. Soc. Am., 53: 758-9(1963)
17874	17-25653	Rev. Sci. Instr., 34: 524-9(1963)
17960	17-25575	Rev. Sci. Instr., 34: 504-9(1963)
18016	17-24902	Acta Genet. Med. Gemellol. (Rome), 11: 356-89(1962)
18072	17-25414	Dep.; $1.75(OTS)
18372	17-25445	J. Geophys. Res., 68: 3531-5(1963)
18380	17-25234	Science 140: 899-900(1963)
18593	17-25561	Electronics 36: 46-8(1963)
18606	17-24846	IAEA Preprint No. SM-40/29. To be published in IAEA Proceedings of the Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, held in Athens, Greece, Apr. 22–26, 1963
18623	17-26602	Phys. Rev. Letters, 10: 403-5(1963)
18667	17-25389	Dep.(mc); $5.60(fs), $1.76(mf) OTS
18672	17-24893	Dep.(mc); $5.60(fs), $1.88(mf) OTS
18673	17-24894	Dep.(mc); $2.60(fs), $1.01(mf) OTS
18683	17-25481	Dep.(mc); $2.60(fs), $0.83(mf) OTS
18684	17-25164	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18690	17-25432	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18691	17-25390	Dep.(mc); $12.00(fs), $5.03(mf) OTS
18697	17-25165	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18699	17-25043	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18703	17-25676	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18705	17-25865	Dep.(mc); $2.60(fs), $1.10(mf) OTS
18706	17-25415	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18708	17-25482	Dep.(mc); $3.60(fs), $1.25(mf) OTS
18710	17-25424	Dep.(mc); $3.60(fs), $1.31(mf) OTS
18713	17-24848	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18717	17-25416	Dep.(mc); $10.50(fs), $4.22(mf) OTS
18721	17-24895	Dep.(mc), $1.10(fs), $0.80(mf) OTS
18723	17-24896	Dep.(mc); $6.60(fs), $2.15(mf) OTS
18727	17-26794	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18738	17-25781	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18744	17-26889	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18749	17-25282	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18752	17-25866	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18754	17-26927	IAEA Preprint No. CN-14/41. To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, held in Salzburg, Austria, May 27–31, 1963
18758	17-25340	IAEA Preprint No. CN-14/17. To be published in IAEA Proceedings of the Conference on the Application of Large Radiation Sources in Industry, held in Salzburg, Austria, May 27–31, 1963
18759	17-25483	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18760	17-24834	Dep.(mc); $2.60(fs), $0.98(mf) OTS
18761	17-26245	IAEA Preprint No. CN-14/22. To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, Salzburg, Austria, May 27–31, 1963
18762	17-25604	Dep.(mc); $2.60(fs), $1.01(mf) OTS
18765	17-25339	IAEA Preprint No. CN-14/18. To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, Salzburg, Austria, May 27–31, 1963
18766	17-25708	Dep.(mc); $3.60(fs), $1.22(mf) OTS
18768	17-25867	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18769	17-25166	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18773	17-25724	Dep.(mc); $8.60(fs), $3.02(mf) OTS
18776	17-26467	Dep.(mc); $4.60(fs), $1.58(mf) OTS
18783	17-26647	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18791	17-25782	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18792	17-24897	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18793	17-25342	IAEA Preprint No. CN-14/24. To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, held in Salzburg, Austria, May 27–31, 1963
18794	17-24898	Dep.(mc); $3.60(fs), $1.37(mf) OTS
18795	17-25343	IAEA Preprint No. CN-14/23. To be published in proceedings of Conference on the Application of Large Radiation Sources in Industry, held in Salzburg, Austria, May 27–31, 1963
18812	17-25287	Dep.(mc); $1.10(fs), $0.80(mf) OTS
TIM–	**(Misc.)**	
682	17-25553	Dep.(mc); $4.60(fs), $1.46(mf) OTS
TRG–	**(Misc.)**	
132	17-25690	See NYO-10472
TRG-Inf. Ser.–	**(British)**	
295	17-25709	Dep.; $0.49(BIS); 3s. 6d. (HMSO)
TRG-Report–	**(Non-AEC)**	
516	17-25554	Dep.; $0.49(BIS); 3s. 6d. (HMSO)
523	17-25555	Dep.; $0.70(BIS); 5s. (HMSO)
524	17-25556	Dep.; $0.63(BIS); 4s. 6d. (HMSO)
537	17-25748	Dep.; $0.25(BIS); 1s. 9d. (HMSO)
UAC–		
6142	17-26903	See TID-15532
6419	17-25363	See TID-16152
6643	17-25305	See TID-16934
6644	17-25897	See TID-16935
6663	17-24982	See TID-16881
6701	17-25396	See TID-16932
6907	17-25187	See TID-17428
7045	17-25653	See TID-17874
7175	17-25445	See TID-18372
UCRL–		
7025	17-26710	Phys. Fluids 6: 857-64(1963)
7045	17-25167	Dep.(mc); $1.10(fs), $0.80(mf) OTS
7063	17-26526	Nucl. Phys. 43: 405-12(1963)
7087	17-26291	Dep.; $1.25(OTS)
7107	17-26675	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7196	17-25677	Dep.(mc); $7.60(fs), $2.42(mf) OTS
7210	17-25783	Dep.; $0.75(OTS)
7253	17-26676	Dep.; $0.50(OTS)
7283	17-25955	Phys. Rev. Letters 10: 397-8(1963)
7289	17-25784	Dep.; $0.50(OTS)
10399(Rev.)	17-26696	Phys. Fluids, 6: 699-708(1963)
10525	17-26573	Phys. Rev., 130: 2383-7(1963)
10566	17-25932	Phys. Rev., 130: 2325-32(1963)
10574	17-26593	Phys. Rev. 131: 337-51(1963)
10592	17-26523	Nucl. Phys. 43: 367-71(1963)
10600(Rev.)	17-26369	Phys. Rev. Letters, 10: 416-20(1963)
10624	17-24750	Dep.; $4.50(OTS)
10676	17-26339	Phys. Rev., 130: 2481-4(1963)
10695	17-26468	Dep.(mc); $2.60(fs), $1.10(mf) OTS
10714	17-25785	Dep.(mc); $3.60(fs), $1.37(mf) OTS
10715	17-25817	Science, 140: 481-3(1963)
10718	17-26292	Dep.; $2.25(OTS)

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10734	17-25678	Dep.; $0.50(OTS)
10748	17-25868	Dep.(mc); $2.60(fs), $0.89(mf) OTS
10765	17-26469	Dep.(mc); $2.60(fs), $1.07(mf) OTS
10767	17-26470	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10780	17-26471	Dep.; $2.50(OTS)
10805	17-25869	Dep.(mc); $3.60(fs), $1.22(mf) OTS
13075	17-25786	Dep.(mc); $1.60(fs), $0.80(mf) OTS
USNRDL-TR-	**(Non-AEC)**	
636	17-24899	$1.60(OTS)
VDIT-	**(Swedish)**	
16(3.2)	17-25832	Dep.(mc)
WADC-TR-	**(Non-AEC)**	
59-575(Pt.III)	17-25725	$1.75(OTS)
WADD-TR-	**(Non-AEC)**	
61-91(Pt.III)	17-25425	
WANL-PR-	**(Misc.)**	
(N)-001	17-25749	Dep.(mc); $1.60(fs), $0.80(mf) OTS
WAPD-MRP-		
103	17-26870	Dep.; $2.50(OTS)
WAPD-TM-	**(Misc.)**	
367	17-25679	Dep.; $2.00(OTS)
WCAP-	**(Misc.)**	
1570	17-25168	Dep.(mc); $2.60(fs), $0.89(mf) OTS
4187	17-26871	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6054	17-26872	Dep.; $2.50(OTS)
X-	**(Non-AEC)**	
62-11400	17-25870	
Y-KH-		
19	17-25557	Dep.(mc); $1.60(fs), $0.80(mf) OTS